SCHOOL ARCHITECTURE

BY

JOHN J. DONOVAN

AND OTHERS

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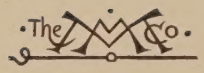
SCHOOL ARCHITECTURE

PRINCIPLES AND PRACTICES



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SCHOOL ARCHITECTURE

PRINCIPLES AND PRACTICES

BY

JOHN J. DONOVAN, B.S.

ARCHITECT

MEMBER OF THE AMERICAN INSTITUTE OF ARCHITECTS

AND OTHERS

WITH ILLUSTRATIONS

New York

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Dedicated

TO THE ADVANCEMENT OF AMERICAN EDUCATION

AND

WITH DEEP AFFECTION

TO MY WIFE AND TO MY MOTHER

WHOSE STEADFAST LOYALTY

AND SYMPATHY

HAVE MADE MANY THINGS POSSIBLE

FOR ME

PREFACE

When the necessity for a comprehensive book of this kind was realized by the writer, it was his first intention to offer a treatise on the planning of school buildings, written wholly from the architect's point of view. After a few months of effort it dawned upon him that in order to make the most thorough use of such information, it would be more valuable to both architect and schoolman if the organization of American schools were first discussed and emphasized as a basis for the discussion of the architectural features. Thus the application of modern school architecture to modern school development could be concisely and logically shown. This plan has been followed. Information on the organization of schools was very much needed by the writer when he first turned his attention to the architecture of school buildings, and, no doubt, such a need is felt by many others who are now approaching the subject.

It must be realized that the old school, even that of five years ago, has passed just as surely as the little red schoolhouse that once stood on the hill. In its place has already appeared the new, throbbing, spirited institution, receiving its impulse from the heart of industry, commerce, and society, which, in turn, are looking to the school for practical aid in the solving of their accumulating problems of trade, employment, and American citizenship. But this new school cannot stand alone; it must rest on the foundations and traditions of its predecessor, just as the nation depends on the securely anchored constitutional footing given to it by its founders. It is this transition which the schoolman and the architect, working together and in sympathy, must bring about with saneness and economy.

The organization of the school, through the extension of its branches, has become very complex to many who are out of touch with it; to those intimately associated with it, it is seen as a clearly unified development. The writer understood, that, if the organization was to be properly presented, it should be described by those who know it best. Therefore, the collaborators were selected with much care, and their contributions are a very important part of the book. A deep debt of gratitude is felt for all the assistance these associates have given; they have entered into the work with a zeal and interest that has surpassed all anticipation. The conferences and discussions have been a great pleasure and an education in themselves.

Particularly has the author profited in discussing the problems of the school with Mr. William F. Ewing, formerly Director of Business Affairs of the Technical High School, Oakland, California, whose vision of the school of the future is most delightfully hopeful; and with Dr. Edna Watson Bailey, Head of the Science Department of the University High School of the same city, who is eminently successful in arousing the interest of her students.

Acknowledgment is due for the encouragement and aid so cheerfully extended by Mr. William C. Bruce, Editor of the *American School Board Journal*, and by Mr. W. H. Crocker, Editor of the *American Architect*, whose splendid journals have often been a source of valuable information; also to Mr. George M. Thiriot, Head of the Academic Department of the Technical Continuation School, Oakland, California, for his valuable assistance in editing the manuscript prepared by the writer.

The author is deeply grateful to his fellow architects who have so kindly furnished photographs and drawings of their work. He hopes the book will be helpful in providing plans for schoolhouses in which the highest ideals of the American school may be more effectively realized.

John J. Donovan

Oakland, California
June, 1920

INTRODUCTION

During the past quarter century, each succeeding year has witnessed the broadening development of public education. The relation of the school to the community has radically changed. Systems of education have been evolved as the result of the careful observation of those engaged in pedagogy, and these systems have become broadened and extended until the present aspect of modern educational methods is closely allied to the best elements of paternalism.

With this evolution and extension of educational methods it was logical to assume that the modern schoolhouse would keep pace in its designing and planning. In addition to the development of the school building and its surroundings for educational purposes, there has been developed, particularly in the larger cities, a further use of the schoolhouse as the community center. This added use of the school building has increased the problems that are present in the arrangement of plan and the perfection of design.

The problem, therefore, that confronts the architect who undertakes to provide school accommodations is perhaps more complex than any other professional task he may be given. The very elements of paternalism that surround the modern school building not only carry with them the obligation to provide such convenient and attractive features as are possible of attainment with the money available, but there is also the even more important element that looks to the safeguarding of the pupils' health and the measures that will be necessary to protect them from every possible injury.

Architects engaged in this responsible work need to know the essentials of hygiene and sanitation. Ventilation, heating, lighting, both natural and artificial, must all be carefully considered. Men who have spent years of successful practice in the solution of the problems that surround the modern schoolhouse will have acquired as the result of long practice, close study, and observation, a wide fund of information that is practical and valuable as it is based on actual operations.

The successful stage to which schoolhouse design has been brought in this country is primarily due to three groups of men who prominently stand forth as the best exponents of the development of the modern school buildings. These groups, located on the eastern seaboard, in the middle west, and on the Pacific coast, are responsible for the development of successful types of school buildings. The author of this book is prominent among the members of these three groups. His success in the special field of architecture, to which he has devoted so many years of practice, makes this work absolutely authoritative and dependable. Its method of preparation is calculated to greatly simplify its use as an encyclopedic treatise on the subject. Whether used by architects, members of school boards, superintendents, or any of the many people who are directly interested in the various phases of the modern schoolhouse and modern educational methods, this work clearly sets forth the answer to every question that is likely to arise.

W. H. Crocker

Editor, *The American Architect*

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OREGON
Astoria: Central Grammar School, 609, 610, 611, 612.
Portland: Benson Polytechnic High School, 434, 448, 449, 455, 458 (shops); 528, 529, 530, 532, 533, 535, 536 (boiler and fan rooms).
Fernwood Grammar School, 620, 621.
Franklin High School, 537, 538 (boiler room); 547 (toilet room).
Lincoln High School, 152, 153, 154, 155, 156.
New Couch School (fan installation), 539, 540.

PENNSYLVANIA
Pittsburgh: Schenley High School (interior views); 296, 313, 315, 334, 383, 391, 492, 501; 663, 664, 665.
Williamson: Free School of Mechanical Trades, 176.

WEST VIRGINIA
Parkersburg: High School 314 (assembly hall); 686, 687, 688, 689.

WISCONSIN
Fond du Lac: Edward S. Bragg School, 100, 101; 337 (assembly hall gymnasium).
Milwaukee: Boys' Technical High School, 181.

SCHOOL ARCHITECTURE

CHAPTER I

SITES AND GROUNDS

By John J. Donovan, B.S., *Architect*, A.I.A.

General Plan of School Sites. Zone Planning. Characteristics of Good School Sites. Size of School Sites. The Elementary School Play Areas. The Junior High School Play Areas. High School Sites. Location of the Building. Surfacing of Playgrounds. (1) Oil Macadam. (2) Asphalt Surfacing on Rock. (3) Asphalt Surfacing on Concrete. Fencing of Grounds. Wider Use of School Grounds. Play Yard Accommodations.

The arts, the architecture, the literature, and the laws of a nation reflect the culture and intelligence of its people at every period of its history. In this day and age, however, the selection of school sites is a fair indication of the wisdom and farsightedness of the representatives of our people and of the people themselves, so important has such selection become.

The school building has its limitations, but the site has none. As a school site it may be abandoned on account of changes in residential or industrial conditions. But if it is well chosen for the intrinsic values a school site should have, it will always be valuable either to the school department as school grounds, or to the municipality as public playgrounds.

While the vision of the people as a whole has been slower than the growth of the school and the activities surrounding it, nurturing that vision by constructive suggestion is probably better than railing about the errors of the past. Patriotism and civic interest, now so brilliant, will do much to dispel shortsightedness and the lack of understanding of the great problem of good citizenship, which is founded on education and the associations and activities allied with education. The great war has strengthened many of the frailties of humanity and awakened the nation to the necessity of health and physical vigor as well as of scientific intellectual development. For the health of the mind seldom rises above the health of the body, and a healthful, vigorous body is the foundation for a sound, vigorous mind. They are parallel, and the rounding out of both should be simultaneous. Therefore, when discussing a school plant, either of one or of many schools, visions of children and adults at play and recreation should be uppermost in mind. Playgrounds are as important a part of the equipment of an educational plant as the buildings.

The large percentage of rejected young men of draft age who failed to qualify as physically fit for the army or the navy has demonstrated the necessity of supervision of play and physical training for both boys and young men. Also the demands of the new vocations thrust upon girls and women make it mandatory that they too shall have an equal opportunity to prepare themselves physically to meet life's duties with confidence. The great possibilities before the nation rest entirely upon the opportunities for universal physical and intellectual education, not upon the development of a few prodigies. The war has taught many lessons, but none more thoroughly than that of the necessity of physical fitness.

General Plan of School Sites. — Before discussing the selection of a particular site, it would be wise to look at the larger problem of selecting many sites, and of following some definite plan in building up a plant of many separate units. The procrastinating and haphazard custom, so common to nearly all communities, of waiting until congestion forces action for enlarging or extending the existing plant, works to disadvantage, because, when steps are taken, they must of necessity be hasty and often ill-advised. The consequence is that the cost of grounds is greater than it need be if sites were obtained with definite regularity according to a carefully prepared plan that has flexibility as one of its chief assets. Where necessary, present laws should be revised or new laws drawn to enable boards of education to purchase and dispose of land quickly and with the least inconvenience. The present laws are probably ample for the purchase of land; they

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should be revised to permit of the disposal of land easily. They would then permit the buying of land from five to eight years, or longer, in advance of the existing need, and would enable school boards to retain it for school purposes or dispose of it as the later prevailing conditions warranted. Without going into detail here, there are sufficient ways and means to safeguard against fraudulent and incompetent selections. Such selections, even at their worst, could hardly equal the economic waste of the prevailing methods.

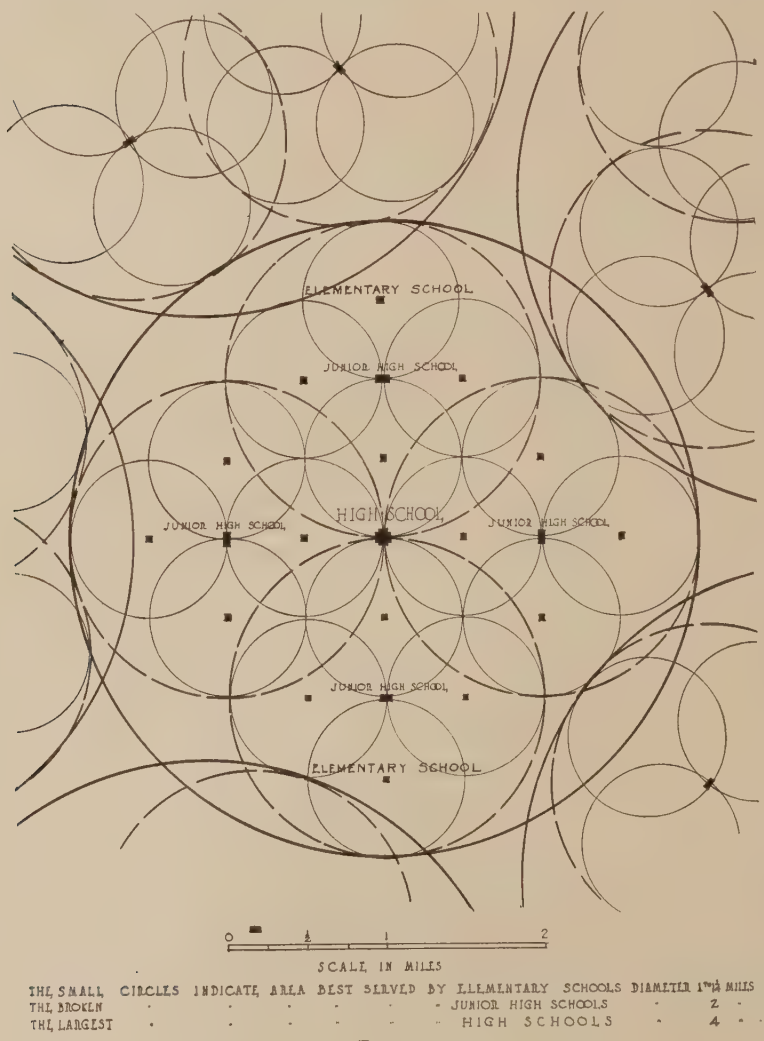

ELEMENTARY SCHOOL
JUNIOR HIGH SCHOOL
JUNIOR HIGH SCHOOL
HIGH SCHOOL
JUNIOR HIGH SCHOOL
JUNIOR HIGH SCHOOL
ELEMENTARY SCHOOL
0
½
1
2
SCALE IN MILES
THE SMALL CIRCLES INDICATE AREA BEST SERVED BY ELEMENTARY SCHOOLS DIAMETER 1½ MILES
THE BROKEN · · · · · · JUNIOR HIGH SCHOOLS · 2 ·
THE LARGEST · · · · · · HIGH SCHOOLS · 4 · ·

FIG. 1.

This leads up to planning for sites, and what kind of property a school board should select for school grounds. First of all, the map of the city should be plotted geographically according to zones based on the census of elementary, intermediate, and high school pupils. If the elementary, intermediate, and senior high school plan is adopted as the educational system of the city, it will make the general planning easier, reduce the cost of housing per pupil, and give greater facilities for immediate relief in times of congestion. Keeping in mind, however, the school population as the basis to work upon, the intermediate schools of the seventh, eighth, and ninth grades should be the centers of circles having radii of one to one and one-quarter miles; the perimeters of these circles should be approximately the line of location of the outer boundary of the elementary school zone. In turn, the elementary schools should be spaced within the intermediate school areas not farther apart than one mile. (See Figures 1 and 1A.) In other words, their location should be the centers of circles whose radii are one-half to three-quarters of a mile, the proximity depending entirely upon the population. Children below the sixth grade (11 years of age) should not be compelled to walk farther to school than one-half to three-quarters of a mile. Special attention should be given to conditions such as railroad crossings, highways much used by automobiles, and active city streets. Good planning will save many a mother unnecessary worry for the safety of her child and often will save the child's life.

Centers for high school zones are not as much restricted in regard to distances apart as are those of the intermediate and elementary schools, for the reason that the students attending the high school are more mature, and many of them arrive by means of bicycles, automobiles, or the street cars. Moreover, high school sites must be of such large acreage that size and cost are important factors, and it is very often the case that suitable sites cannot be found within a mile or more of the center of a high school zone. However, they are a part of the general plan, and the difficulty of obtaining such desirable sites emphasizes all the more the necessity of planning in advance.

Zone Planning. — Zone planning for school grounds is simply another phase of modern city planning whereby the economic saving of the city may be increased through elimination of waste in both the erection of school buildings and the buying and development of school sites.

For instance, zone planning would prevent the needless duplication of a number of departments in the elementary and intermediate schools. Whenever an elementary school attempts to maintain the full number of grades, that is from one to eight, it is necessary to provide a complete plant containing a large assembly hall, sewing and cooking rooms, manual training rooms,

Map Showing the Distribution of Present Schools, Proposed Additions, and Proposed New Schools

FIG. 1 A.

extensive sheltered playrooms, a large administration suite, and other rooms and spaces accessory to classrooms and needed in a school of this kind. These are necessary almost entirely on account of the older pupils in the school, say from the sixth to the eighth grade. Now an examination of the enrollment of the different grades of the elementary school will disclose the fact that the preponderance of attendance is in the lower grades. The result becomes something that no wise business man would tolerate, — a large and expensive part of the plant in use only part time by a minority of the pupils and exactly duplicated in every one of the other elementary schools.

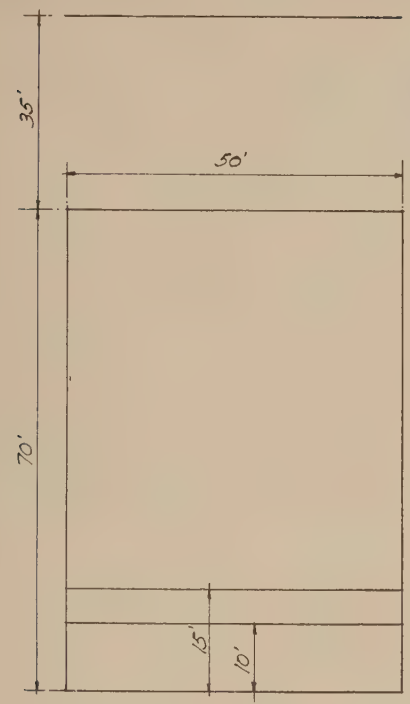
It is this economic waste of duplication that the method of zone planning would eliminate. The upper grades in the elementary school of the present system, from the seventh to the eighth inclusive, and the first grade of the high school, would be concentrated in one centrally located intermediate school which would contain complete departmental equipment for the pupils of these grades. This organization would at once relieve the elementary schools within its zone of the further necessity for such extensive equipment. It is safe to say that one such intermediate school, accommodating 1200 pupils, would provide for about 500 graduates yearly from the near-by elementary schools whose combined enrollment would be from 3500 to 4000 pupils. Nor would this method prevent the construction of any of the above-mentioned departments in the elementary schools wherever they could be so adjusted to the needs of the pupils below the seventh grade that they would be in constant and profitable use during the school day.[1] This plan would further enable school boards to practice economy in securing an adequate site for each kind of school. While it is true that the enrollment of some elementary schools may be larger than that of the intermediate schools, nevertheless the former require smaller areas for playgrounds than the latter, just as the intermediate school requires less space than the high school. This difference is due to the different kinds of recreation required by the pupils of the respective schools. When the development of any school district is planned for in advance, and the general school scheme is carefully plotted, desirable sites can be purchased with much more economy than later when the pressure of increasing population makes their purchase necessary wherever they may be had and at whatever price may be asked. It is true that under present conditions school boards may hesitate about buying land in advance, for fear that it may never be used. This situation, as has been said before, can be changed by the enactment of laws that will permit the disposal of school land whenever such disposal will be advantageous to the community.

The above recommendations for zone planning of school sites would necessarily be modified when considering the housing of educational plants in industrial sections of the school district, or in sections of a city densely populated by foreign-born residents. Every large city is confronted with this special educational problem as well as the housing problem in such districts. Whatever educational methods are adopted they must, of necessity, be flexible so that modifications may be easily and quickly made, in order that the school may retain the interest of not only the pupil but the parents as well. Very often in these districts, the fifth and sixth grades are the termination of education for a great many pupils, who then leave school to seek employment. Consequently, promoting such pupils to an intermediate school in another section of the district, even though it is near by, would in the greater number of cases be equivalent to ending their school attendance. In view of this fact it is the business of the school to provide a type of education for these students which would be attractive enough to hold them beyond the sixth grade. This type should consist of instruction in household arts, industrial arts, and physical education for the pupils in addition to the usual elementary studies, and some form of instruction for adults that will bring the parents into closer contact with the school. This departmental work or vocational education should begin as early as possible in these schools and extend to and include the ninth grade. The vocational training should be thorough, and the teachers should be not only able leaders in this special work but should be in hearty sympathy with the pupils and the parents, without any show of patronizing cant. If the effort to further Americanization of foreigners is to succeed, its strongest impetus must come from the school; for it is by giving to these people the belief that the school is especially for their use and for their social, educational, and industrial development that the effort can succeed.

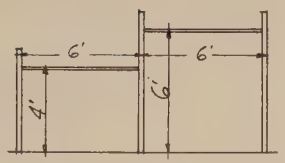
The solution of this problem cannot be prescribed by any long-distance methods but only by close contact with these people and in accord with them. Consequently, such divisions of the general zone planning should be treated differently from the general planning for residential sections; but they should be incorporated into the plan as a whole.

Characteristics of Good School Sites. — Before discussing the matter of size, let us consider the character of sites appropriate to school buildings. As a first step it would be good practice to call in a reputable health

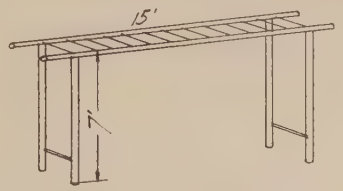
[1] This does not take into consideration the Gary system, which in its curriculum and conduct of studies is different from the general elementary school system in practice throughout the country.



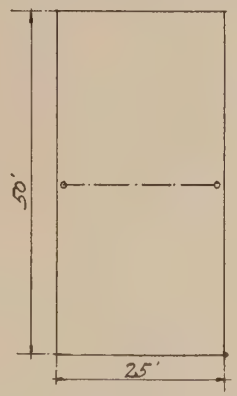
BAT BALL COURT



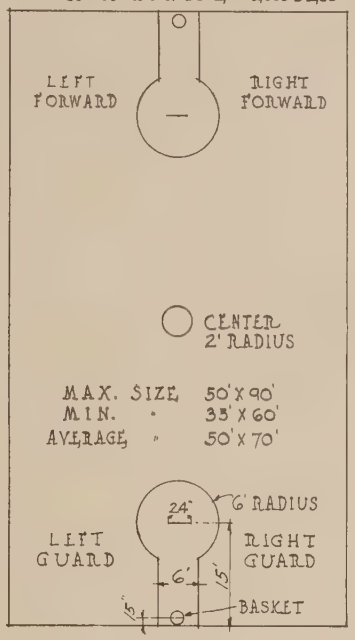
DOUBLE HORIZONTAL BARS



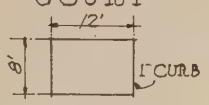
HORIZONTAL LADDER



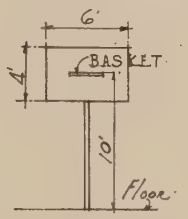
VOLLEY BALL COURT



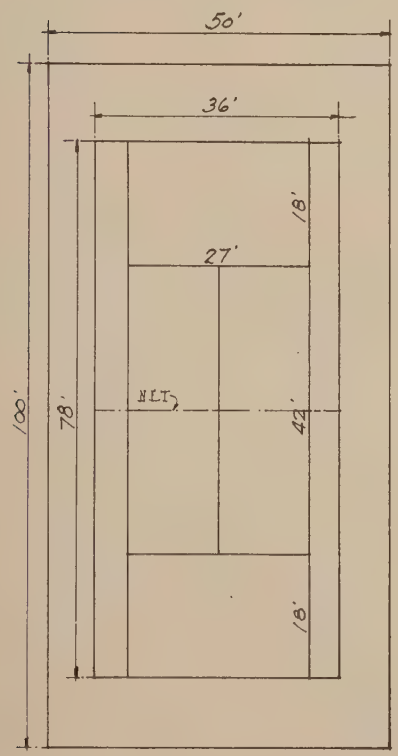
BASKET BALL COURT



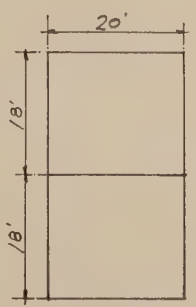
SAND BOX



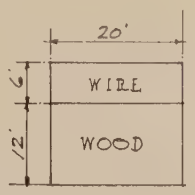
ELEVATION OF BASKET



TENNIS COURT

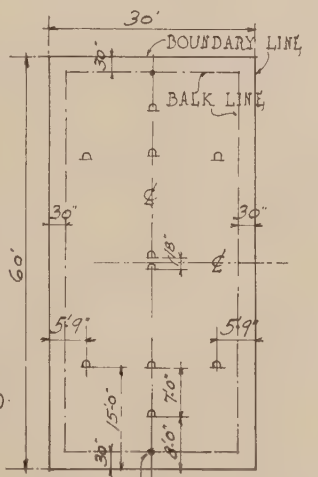


PLAN

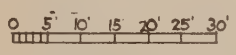


ELEVATION OF END

HAND BALL COURT



CROQUET COURT



SCALE

FIG. 2.

officer to pass judgment upon the sanitation of all sites. This may seem extreme, but surveys of schools and the records of unhealthful conditions found surrounding some selections of even recent date prompt the belief that the advice of a health officer is needed. Low, swampy, boggy land should be avoided. On the other hand, hill sites are of little or no value, for no games can be played on a hillside. The additional expense for grading will probably make the hill site the most expensive in the end, regardless of its first cost. Land suitable for school sites should be nearly level with even gradients sloping down toward the property lines. This statement applies for all schools, although there are times when certain changes in the topography of the lot would offer an opportunity for natural stadiums adaptable for large athletic fields. In these cases the vision and training of a good planner will be required, not only to discover, but to execute. Many a splendid opportunity in the selection of school sites has gone begging because of lack of vision.

Sites along railroad tracks should be rejected on account of danger and noises. Also, sites on streets having car lines should be carefully studied with reference to the location of the buildings and their proximity to the street. If the site is large enough to permit placing the building at such distance from the car lines that the noise will not be disturbing, and if the resulting location of the building does not destroy the grounds for play and athletic games, such sites may not be objectionable. Even then, however, there may be cause for doubt.

Locations adjacent to factories, boiler shops, stables, fire hazards, hospitals, fire-engine houses, jails, or any such buildings should never be purchased. Furthermore, local ordinances should prevent any such buildings from being erected after a school site has once been purchased and built upon. Before any site is selected for school purposes, a careful survey should be made of the actual conditions of the land, of its possibilities for development as a school site and playground, and of the buildings and their uses within 1500 feet of the proposed site. If this is done by disinterested persons, and their findings recorded, there will be very few objectionable school sites purchased by school departments. That this may be done thoroughly, a printed questionnaire or form including all objectionable and all favorable features should be given to the committee on sites. Also a topographical drawing or survey showing the grades and lot lines, prepared by a reputable engineer, should be required of every owner desiring to sell land for school property, or should be made at the school board's expense before the transaction is closed. Such a survey may not always be necessary, but it costs so little and is generally of such use that it is worth while.

Size of School Sites. — The question of the size of school grounds should be approached from the practical as well as from the ideal viewpoint. It would bankrupt any city if all the school sites were of such large acreage as to permit running tracks, football fields, etc. Moreover, school sites within such highly developed zones as interior city blocks are so costly that if schools must be placed within such zones, it is often necessary to limit the school site to a single block, or even less. City blocks are usually of such dimensions as $200' \times 300'$, $250' \times 300'$, or $200' \times 400'$; an acre contains 43,560 square feet; therefore, the block of the first dimensions would contain 1.38 acres, the second 1.7 acres, and the third 1.84 acres. None of these lots, after allowing sufficient room for the building and certain reservations for the future growth of the school, will leave space enough for a baseball field of regulation size. They will, however, provide ground space for tennis, handball, basket ball, volley ball, indoor baseball, and play space for the smaller children. Consequently, as far as possible, such sites should be limited to elementary schools. This does not mean, however, that all elementary school sites should be restricted in area to city blocks. On the contrary, elementary school sites should contain from $2\frac{1}{2}$ to 3 acres as a minimum, and decidedly so if the school is to house more than 500 pupils. This area will become more and more mandatory, as many states already require physical education as part of the school curriculum. According to the recommendation of the National Education Association, of 272 square feet per child for play, recreation, and gardening, it is evident that an area of three acres is not too large for an elementary school site.

A review of the opinion of Mr. Henry S. Curtis,[1] former Secretary of the Playground Association of America, seems at first sight to indicate a smaller allotment of space. "Curtis's estimate for elementary school buildings calls for two acres. Organized games — baseball, indoor baseball, volley ball, tennis, basket ball — call for $1\frac{9}{20}$ acres, leaving $\frac{11}{20}$ acre for general, unorganized play, running track, and pool. Curtis's estimate on the basis of two acres for 684 pupils is equivalent to 127 square feet per pupil for elementary schools." Since nothing is said about the space to be occupied by the building itself, evidently the article is dealing with play space only. This fact will then account for the difference between the figure of 272 square feet per

[1] Report of the Commission on the Reorganization of Secondary Education appointed by the National Education Association. Published by the Federal Bureau of Education in Bulletin 1917, No. 50.

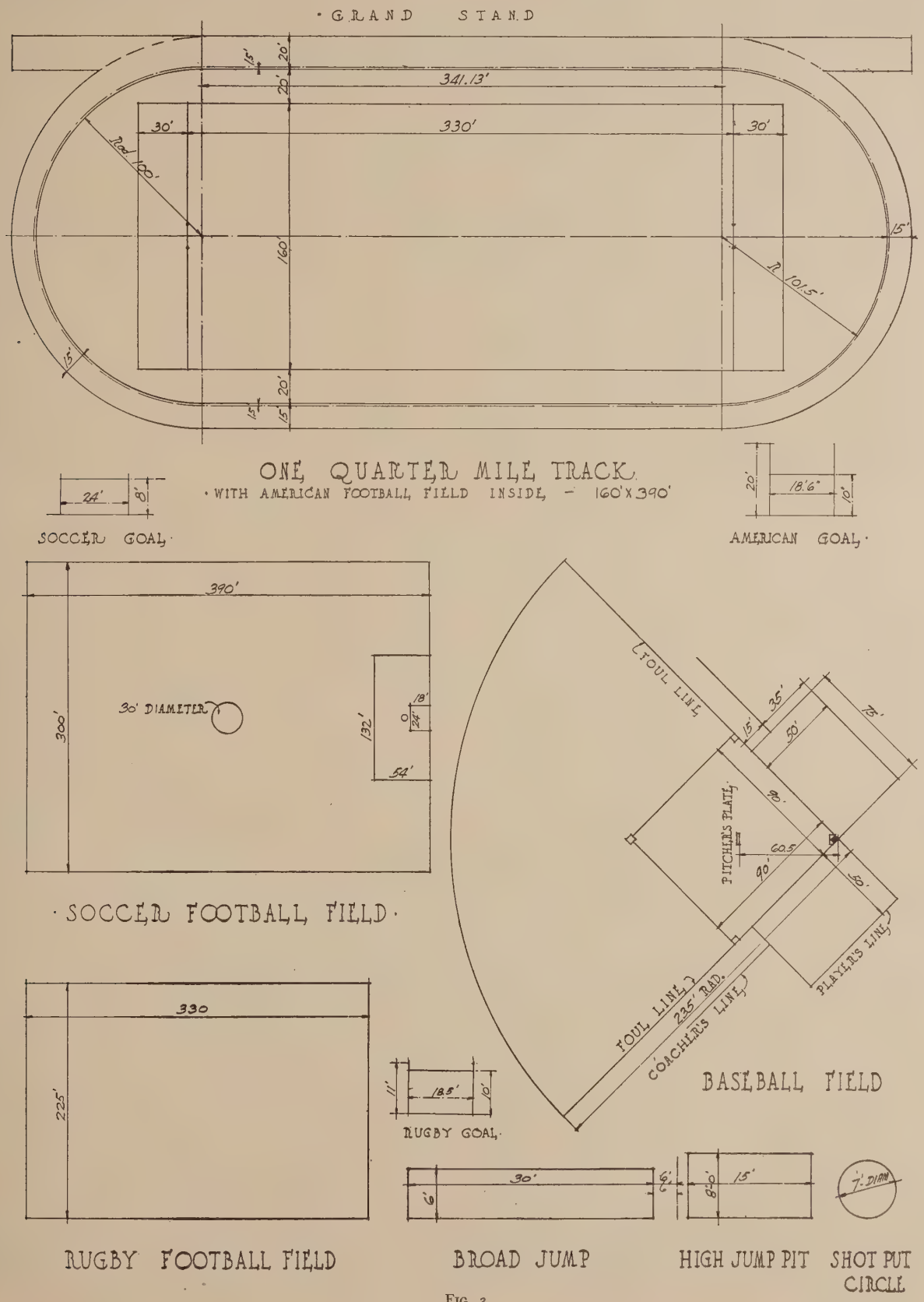

GRAND STAND
15'
20'
20'
341.13'
30'
330'
30'
R 100'
160'
15'
R 101.5'
15'
20'
15'
15'
ONE QUARTER MILE TRACK
WITH AMERICAN FOOTBALL FIELD INSIDE, - 160'X390'
24'
8'
SOCCER GOAL
20'
18'6"
10'
AMERICAN GOAL
390'
300'
30' DIAMETER
132'
18'
24'
54'
SOCCER FOOTBALL FIELD
FOUL LINE
15'
35'
75'
50'
90'
PITCHER'S PLATE
60.5'
90'
50'
FOUL LINE
225' RAD.
COACHER'S LINE
PLAYER'S LINE
BASEBALL FIELD
330
225'
11'
18.5'
10'
RUGBY GOAL
RUGBY FOOTBALL FIELD
30'
6'
6'
BROAD JUMP
8'6"
15'
HIGH JUMP PIT
7' DIAM
SHOT PUT CIRCLE

FIG. 3.

pupil demanded by the National Education Association and the figure of 127 square feet given by Mr. Curtis. The former is an allowance of space of about 15′×18′, and the latter about 10′×13′ per pupil. These dimensions are quoted to enable school boards to see how men familiar with recreation activities are attacking the problem of preserving and developing the health and physical fitness of school children.

The Elementary School Play Areas. — The following equipment and areas are recommended by the writer for elementary school playgrounds and are separate from the baseball field. (See Figure 2.)

1. *Boys' Yard.*

One basket ball court 50′×70′	3,500	square	feet
One tennis court 50′×100′ (court proper is 36′×78′) over all	5,000	"	"
Two volley ball courts, each 25′×50′	2,500	"	"
Two handball courts, each 20′×36′	1,440	"	"
Allowance around courts about	4,000	"	"
Space for gymnasium apparatus	5,000	"	"
General play space at least	20,000	"	"
	41,440	"	"

2. *Girls' Yard.*

One basket ball court 50′×70′	3,500	square	feet
One tennis court 50′×100′	5,000	"	"
Two volley ball courts, each 25′×50′	2,500	"	"
One handball court 20′×36′	720	"	"
Allowance for space around courts	4,000	"	"
Gymnasium apparatus	5,000	"	"
Dancing pavilion 30′×60′	1,800	"	"
General play space	10,000	"	"
	32,520	"	"

3. *Small Children's Space.*

Sand box, Swings, See-saws, Slides } about 5000 square feet.

The above requires a total area of about 78,960 square feet, or about 1.7 acres.

The Junior High School Play Areas. — The junior high school site is quite another matter, and as this school should be the general center of community interest, it follows that the grounds should have the same relation to outdoor activity as the building has as a place for meetings of citizens vitally interested in civic affairs. Many are of the opinion that it is an economic waste to provide especially designed rooms for public clubrooms in every school, because they are used so infrequently and by so few that the expense is needless, and the money could be more wisely spent in providing additional classrooms for instruction of children for whom the school is built. On the other hand, it may be recommended most heartily that such provisions be afforded in schools centered like the intermediate school. A mile or a little farther is not too far for a man or woman to travel to attend community affairs. The larger the district, the larger the number likely to attend, and the greater the number, the more likely will better understanding and judgment prevail. All schools should be free for use by the people and at their pleasure, but only in central schools should special provisions be made, such as clubrooms and especially large playgrounds.

The junior high school grounds should be the combination of the municipal and school playground, and consequently should be large enough to permit at least two baseball games to be played at the same time, and to provide for other games as well. The three-acre tract for the elementary school will permit of one baseball field of regulation size, and this will also provide space for the play of the smaller children, besides providing tennis and other courts for adults. However, the opportunity for community development will be found in the junior high school and its grounds.

The following is a good example of the area required for such a school site:

(1) The athletic field should include a quarter mile running track. The space within the oval will provide for two baseball diamonds, or one football field. High jump, broad jump, and pole vault pits can be placed inside this inclosure. The area required for this is about four and one-half acres. (See Figure 3.)

(2) Four tennis courts, each 60′×120′, should be provided and will require an area of 28,800 square feet. To this should be added about 10% for approaches. Therefore, the allowance for tennis is about $\frac{3}{4}$ of an acre.

(3) One swimming pool about 30′×75′ (for the pool only) with dressing rooms for about 75 men and 50 women. This will require about $\frac{1}{4}$ of an acre. It is quite unlikely that a swimming pool would be provided in the grounds or buildings of every intermediate school. But a city having such schools and public playgrounds should have at least one swimming pool for every 25,000 in population.

(4) In addition to the above there should be three smaller divisions of the grounds as follows:

(A) Boys' division, containing:

2 Basket ball courts.
2 Handball courts, each 20′×36′.
2 Volley ball courts.

Space for gymnasium apparatus, about 5000 square feet. All of which will require about 16,500 square feet or about $\frac{4}{10}$ of an acre.

(B) Girls' division, containing:

2 Girls' basket ball courts.
2 Handball courts.
2 Volley ball courts.

Space for girls' gymnasium apparatus, about 5000 square feet.

Indoor baseball grounds with base lines 40 feet in length, allowing about 2000 square feet.

Dance platform and provision for using piano, about 2500 square feet, or a total of about 20,440 square feet, nearly $\frac{1}{2}$ an acre.

(C) Small children's division containing: Sand boxes, swings, seesaws, and slides. This space will require about 8500 square feet, or about $\frac{1}{5}$ of an acre. This section should be isolated from the rest of the grounds and sufficiently removed from the building that it may be opened for use without restriction as to time during the day by the very small children accompanied by their mothers or nurses. At the elementary school, the small children's play space and equipment should be arranged close to the building, as it is not used except at recess periods.

The plan outlined above, without taking into account the building area, approaches, lawns, gardens, etc., equals about 7 acres; so it is safe to say that an intermediate school site which will serve as a community center will require at least 10 acres, which space is quite in keeping with the recommendation of the National Education Association of 272 square feet per pupil.

In order that adults, intermediate school pupils, and smaller children may occupy the grounds at the same time, it is advisable that the entire site be properly planned, setting off spaces for the different classifications of play, and that some of the divisions be formed by appropriate wire fences or hedges. The space for the boys and adults requires little or no division. The gardens, however, require protection from the outside and from the play space, and the girls' play area should be separated from the boys' play yard and field by a fence, hedge, or terrace.

As in the planning of buildings, there is every opportunity to be wasteful in the planning of school grounds; therefore, every precaution is necessary to prevent useless waste, especially in overlapping the areas for games. It is greatly desired in the laying out of the grounds that an experienced physical director collaborate with the architect and the landscape designer. Such coöperation of experts will bring about the planning of grounds adaptable to the curriculum, will assure the movement of the school to and from the grounds between the periods, and will pave the way for utility and order in the general treatment.

High School Sites. — Sites for high schools should be enlarged to about double the size of those for intermediate school grounds. This is recommended because high school grounds should have the character of the college campus. The day has arrived when high schools are being planned as groups of buildings, not more than two or three stories high, with the different departments in separate buildings connected by open or inclosed arcades or wings. In the larger cities, due to cost of land, it may be necessary to have the high school under one roof and within the limits of a single block. This means that there must be four or more stories to the building. But the trend of the times is to locate secondary schools in sparsely settled sections of the cities where the buildings may be spread out and their height reduced. This is desirable, as it means better lighting, better natural ventilation, fewer fire hazards, besides reducing the exertion of stair-climbing for girls. High schools planned in this manner give many opportunities for pleasing courts, and approaches, at the same time furnishing to the plan spaces for lawns, shrubs, trees, etc., which in this manner are isolated from the playgrounds and preserved. Properly treated school foregrounds and courts are valuable points of interest in communities.

Cities keeping step with progress in education are providing high school sites containing twenty to twenty-five acres. Experimental gardens alone will require from three to five acres. The trade and industrial shops of the industrial arts department are generally planned to occupy separate buildings set some distance from other departments which require quietness. The gymnasium, closely allied with the athletic field, should also be in a separate building. The same is somewhat true of the music department with all its accompanying noises. It is also necessary that the girls should have a separate athletic field from that of the boys, as a great deal of the physical training, now compulsory, will be done in the open air. Therefore, in order to meet the many and diversified requirements of secondary education, large areas of ground for high schools are to-day as essential as large buildings.

Location of the Building. — Many a well-planned school has been made almost useless by misplacing it on the site. Care should be taken to determine the disturbances surrounding the site, as has been previously mentioned, and consideration given to future possibilities of new street car lines passing the school long after it is built. Likewise the fact must be remembered that small factories, garages, and other shops may locate near a proposed school, if they are not there already. Consequently, the school should be set far enough back from the street property lines to insure quietness for study at all times. Aside from the consideration of noises, it is a good plan to have plenty of space between the exits and the street, so that on leaving school the children will have sufficient time to overcome the excitement and haste which usually follow dismissal. Many accidents can be attributed to having

the school too close to avenues and streets, always dangerous to heedless youngsters.

If advantage is to be taken of the best orientation for the school and the classrooms, the location of the building is a very important factor. For instance, a rectangular plan, which is usually the most economical, adapts itself well to grounds having an east or west frontage when east and west light is desirable. Other forms of floor plans necessitated by conditions are often dependent upon the orientation of the lot for economy in cost and efficiency in administration.

School children like to play or to congregate close to the building just before school opens and during recess periods; therefore, these features of child life and habits should influence many points about the plan and the location of the building. The entrances used mostly by the pupils and the play spaces near the building are the centers where the children gather. In consequence of this the building should be located so that these spots, as far as possible, may receive the early morning sunshine for warmth and health. Every precaution should be taken to protect the health of children, and there are no more economical means than that of good planning and arrangement of buildings used by children if the authorities are familiar with the child's natural habits.

The question of placing the large play yard or athletic field between the school and the street, or, as is generally the case, placing the building so that the athletic field is to the rear, is a matter which can be decided only after a thorough study has been made of the local conditions. The former plan with small grounds and a wide approach to the main entrance is a definite way to divide the grounds for the boys and for the girls and is one method of preventing noises from the street reaching the classrooms. The plan of having the play yard at the rear or side makes the school more accessible to the pupils and especially to the public. There cannot be any definite rules governing this question, as it is a matter of knowledge of the problem and a complete study of the conditions surrounding the site, as well as of taking into account the orientation of the grounds and building.

Surfacing of Playgrounds. — It is only within recent years that the school play yard has received much attention to make it fit for children to play upon. Of all parts of the plant to be left unfinished, the play yard, with its hollows, rubbish, brickbats, and rough surfaces has been woefully neglected. Usually the entire appropriation is spent in purchasing the site and building, and seldom, if ever, is there any provision in the budget for surfacing of grounds or for planting. Happily the awakening has brought about play yards that are delightful for children to play upon, and order and care have replaced the shiftless, slovenly appearing school playground.

For ordinary purposes, two types of surfaces are needed for a school yard:

(A) General play surface — namely, that type of surface which is adaptable for the large play area. This should be a surface that is not so hard as to cause injuries to children when falling, or so soft as to hinder them in free running games. Most of the large athletic games are played on a surface of this type, such as baseball, football, soccer, hockey, etc. The best surface for games of this sort is lawn, but where expense is a large item, lawns are impracticable. A light sandy soil, when properly watered and rolled, will make a good surface. A sandy loam of a mixture of two-thirds loam and one-third sand, which will pack slightly, is probably the most practical. The particles of sand act as fine separators to the loam and keep the surface porous and prevent it from getting hard. This surfacing should be watered frequently to stay the dust during the summer, and lightly raked or brushed after freezing has set in to keep it soft for football.

(B) The court surface, which is used for court games where a hard, level surface is required to give the ball an accurate bounce. This type of surface is needed in such games as basket ball, tennis, and handball. If the surface is compact as described under (A), a further treatment with asphaltic oil and crushed rock screenings ranging in size from dust to $\frac{1}{4}''$ and thoroughly rolled until the oil is completely absorbed will make a fair surface for these games. This, however, will never be very satisfactory and has little permanency. The better and most lasting surfaces for courts, and for areas within 100 feet of the school building, are oil macadam, asphalt on a crushed rock bed, or asphalt on a concrete slab.

The following is a description of the method of applying these three surfaces:

Oil Macadam. — After the surface has been brought to the proper levels for drainage and grades, it should be rolled with a five ton roller until the subsurface is smooth and even. Over this surface should be spread a layer of clean crushed rock $3''$ deep, ranging in size from $\frac{3}{4}''$ to $\frac{1}{2}''$. This layer should then be rolled and covered with a light layer of crushed rock dust or screenings, varying in size from dust to $\frac{1}{2}''$ and rolled until the screenings partly fill the voids between the rock. Upon this surface should be spread one-half gallon of oil to the square yard of surface. Fine screenings should then be dusted over it, and the entire mass rolled until compact and hard. Upon this a second coat of oil should be spread to the extent of $\frac{1}{4}$ gallon to the square yard of surface, this again covered with rock dust until all the free

oil is absorbed, and then rolled thoroughly until the surface is smooth and compact. During the final rolling, rock dust should be sprinkled wherever oil is forced to the surface by the roller. The total depth when finished should be three inches. This pavement at normal times should cost about $4\frac{1}{2}$ cents per square foot. It is kept in repair by oiling, dusting, and rolling the spots showing wear.

All oil should be delivered at the point required for sprinkling at a temperature of not less than 250 degrees Fahrenheit and should contain not less than 90 per cent of asphalt, having, at a temperature of 77 degrees Fahrenheit, a penetration of 80, District of Columbia Standard. There are other requirements and tests for the oil to meet, but the above is sufficient for the purpose of describing how to construct these surfaces.

Asphalt Surfacing on Rock. — This classification is a more permanent method of treating school play yards and is less expensive to maintain. After the subsurface has been graded to the correct levels, a 3″ layer of crushed rock, ranging in size from $\frac{3}{4}$″ to $1\frac{1}{2}$″, should be spread. This surface should be carefully covered with rock screenings so that the voids are partially filled, but not entirely so, and the entire surface thoroughly rolled. On top of this an asphalt wearing surface, one inch in thickness, should be laid and thoroughly rolled with a roller weighing not more than five tons, care being exercised at all times to secure a smooth and uniform surface. The final depth of this surfacing should be four inches. Under normal conditions, this pavement costs approximately $14\frac{1}{2}$ cents per square foot.

Asphalt Surfacing on Concrete. — This is by far the best wearing surface for tennis and other courts and is the most permanent. It differs from asphalt on rock only in the substitution of concrete, at least 3″ thick, for the crushed rock. It costs approximately 18 cents a square foot.

In all surfacing care should be taken to grade the subsurface so that the finished work will be of the required thickness and at the same time shed water without forming gullies. This can be accomplished by installing catch basins and drains and sloping the ground to them with easy gradients. This will preserve the surfacing, avoid hollow spots for puddles, and enable the grounds to dry quickly.

Brick and cement pavements should be used only for walks. The former is too dangerous, and soon wears out the shoes and tears the clothing of the children, and like the latter, having no resilience or "give" to the pressure of the feet, is very tiring. When used for walks these pavements should be laid flush with the play yard.

Fencing of Grounds. — The play yard fence is the part of the equipment most difficult to justify on paper, and yet it is the most essential in practice. In addition to the protection of children from the danger of street traffic, and the aid it affords in the enforcement of rules and regulations, it gives a spirit of individuality to the play yard. Inside the playground fence exist a certain code of ethics and form of procedure that differ from those of the street or vacant lot. This feeling can be made strong enough to become an incentive to good conduct. Fences might be well covered with climbers, and add not only beauty to the grounds, but protect girls from the gaze of idle passers-by. When covered with vines, they serve well as a low base or screen for electric light poles with which to illuminate the play yard at night for the use of the grounds by the working boys and girls of the community and the older adults. The poles, placed along the fence, present a less hideous appearance, and fewer are needed within the grounds. The better treatment of fencing school grounds is to inclose the play yard and rear only, and to leave the front of the site and approaches to the building unfenced, as such treatment gives a more inviting impression to the public and to the student. The result will be that the school will operate in closer touch with the community.

Wider Use of School Grounds. — Communities are awake to the possibilities of having their school yards used at night and on holidays by adults for games under skilled supervision. Modern illuminating engineering has advanced so that tennis, basket ball, volley ball, and indoor baseball may be played outdoors at night as well as within an armory or an inclosed arena. Both the school and the grounds are coming into active and intensive use, and the people are quick to observe the difference between well-planned and well-equipped grounds and those of the haphazard and indifferently kept school play yards that are of little or no use. The character of a community is improved by good playgrounds. New laws eliminating vicious rendezvous also make it obligatory that the working boys and girls have every opportunity to participate in games on well-kept grounds amidst pleasant surroundings. When once completed, such grounds cost little to maintain, and the returns to good citizenship and good health out-measure all initial cost. Many good playgrounds, open wide for intensive use, will cut down the financial burden in maintaining jails and hospitals, and the attendance within them.

Play Yard Accommodations. — In planning the building, the school toilet rooms for both sexes should be located so as to be accessible to the play space, in order to save duplication in the plumbing. However, adults should never be permitted to use the children's toilets, nor should the children be permitted to use the toilets assigned to the older people. Each should have separate

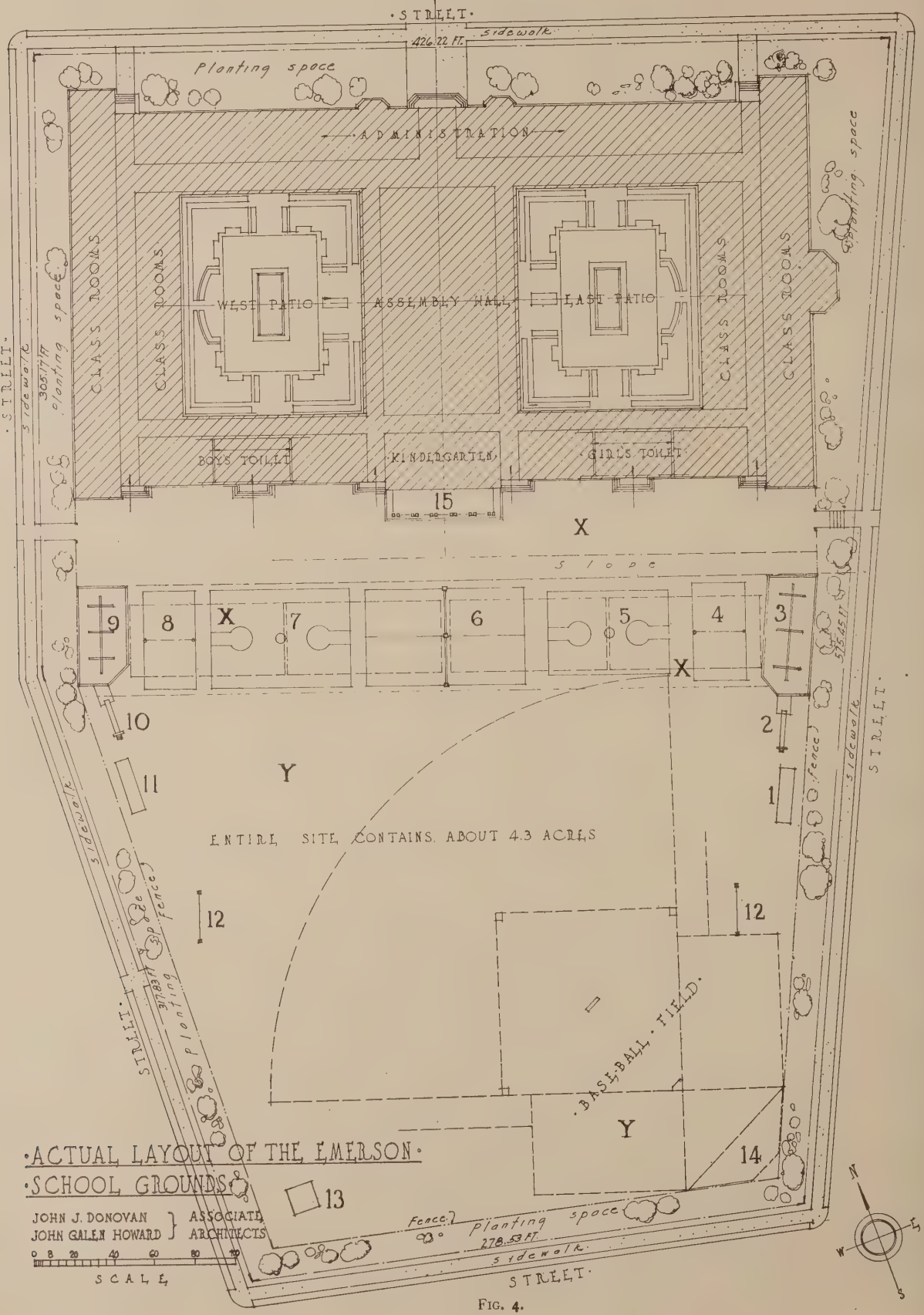
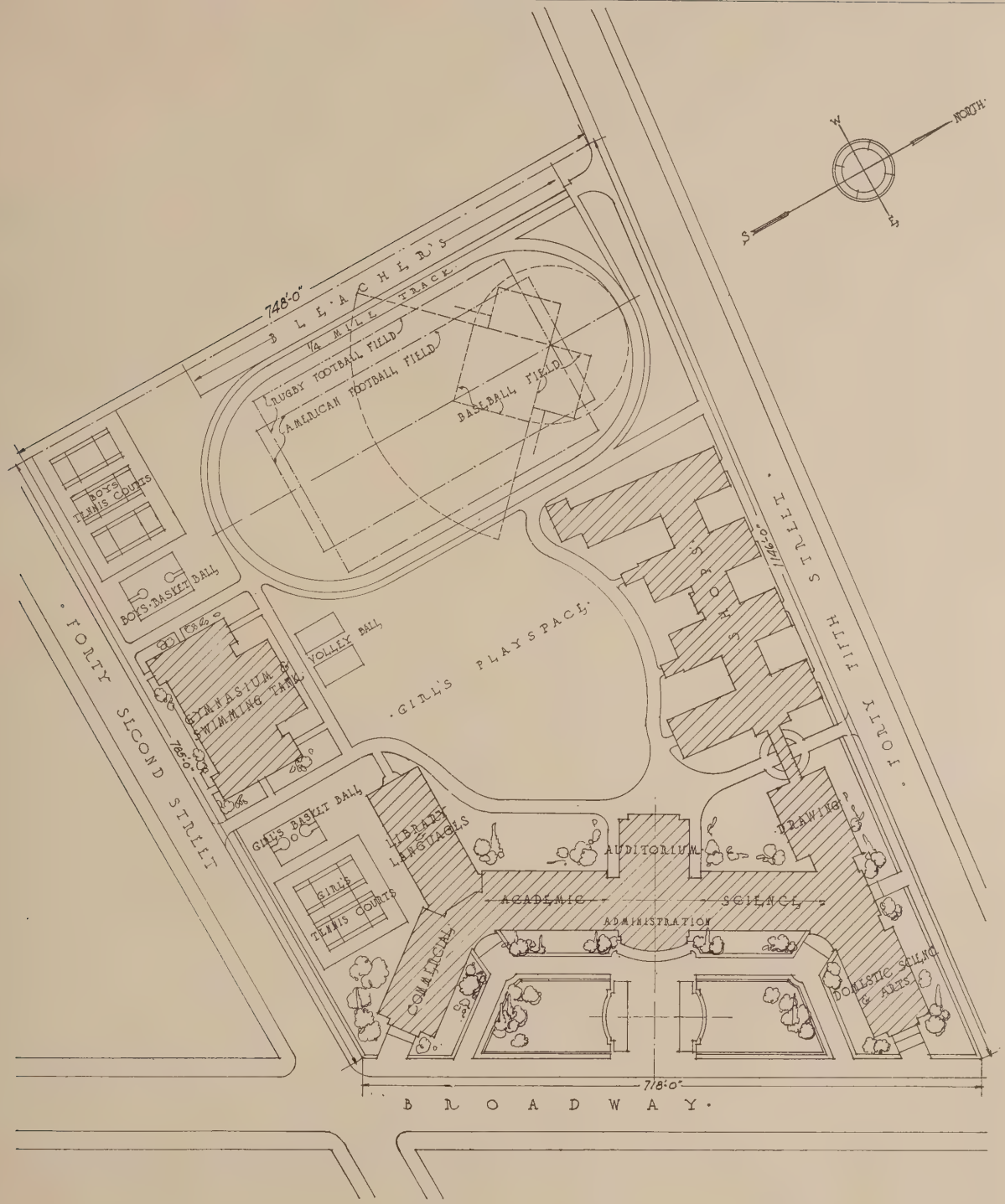

STREET
426.22 FT.
sidewalk
planting space
ADMINISTRATION
CLASS ROOMS
CLASS ROOMS
WEST PATIO
ASSEMBLY HALL
EAST PATIO
CLASS ROOMS
CLASS ROOMS
planting space
STREET
sidewalk
305.17 FT.
planting space
BOYS TOILET
KINDERGARTEN
GIRLS TOILET
15
X
slope
9
8
X
7
6
5
4
3
X
10
2
11
Y
1
ENTIRE SITE CONTAINS ABOUT 4.3 ACRES
12
12
BASEBALL FIELD
Y
14
13
ACTUAL LAYOUT OF THE EMERSON SCHOOL GROUNDS
JOHN J. DONOVAN
JOHN GALEN HOWARD
ASSOCIATE ARCHITECTS
SCALE
Fence
planting space
278.53 FT.
sidewalk
STREET
N
E
W
S

FIG. 4.



GROUP PLAN OF THE OAKLAND TECHNICAL HIGH SCHOOL · OAKLAND · CALIF.

JOHN J. DONOVAN ARCHITECT.

SCALE

ENTIRE SITE CONTAINS ABOUT 14.86 ACRES.

FIG. 5.

toilet and dressing rooms. The same is true of shower rooms. Carelessness in regard to this may lead to a serious infection of an innocent child, a thing which can be easily avoided. Near the dressing rooms should be a small rest room where a first-aid dispensary could be stationed to treat injuries occurring on the playgrounds. A storeroom about 12′×20′ is essential for the storage of supplies and parts of apparatus. These rooms should be placed adjacent to the field and so arranged that access to them may be had without entering the remainder of the school building. The school therefore will serve as a field house and save the expense and space that would be required for an additional building.

Figure 4 is the actual layout or plan of the Emerson School site, Oakland, California, and includes about 4.3 acres. This playground is supervised by the Municipal Recreation Department. The following is a description of the apparatus indicated by the numbers and letters on the diagram:

1. Girls' Sandbox. The dimensions of this are 1×5×12 feet. It is equipped with a shelf around the top, which serves either as a seat or a molding table. It is filled with a coarse grade of sand, which will not become dusty in dry weather or muddy when moistened.

2. Girls' Slide. This is a medium-sized slide, equipped with a landing-pit filled with clean sand.

3. Girls' Gymnasium Frame, which consists of a set of six traveling rings. This particular unit has been found most satisfactory for girls.

4. Girls' Volley-Ball Court, which has 4×4 inch posts set in sockets, so that they may be easily removed.

5. Girls' Basket-Ball Court, — posts set in sockets. (Numbers 4 and 5 are convertible into tennis courts during seasons when basket ball is not played.)

6. Double Handball Courts, one side for girls, and the other for boys. This consists of plain handball backstops, twenty feet wide, twelve feet high, with a six-foot wire extension.

7. Boys' Basket-Ball Court — posts set in sockets.

8. Boys' Volley-Ball Court — posts set in sockets. (Numbers 7 and 8 are convertible into tennis courts.)

9. Boys' Gymnasium Frame. Unit selected for boys' gymnasium frame is one horizontal bar, one climbing-pole, one climbing-ladder, two sets of flying rings.

10. High Slide for Boys, equipped with landing-pit filled with sand.

11. Soccer Posts, made of 6×6 inch posts. Size of field is reduced to 50×80 yards, which has proved satis-

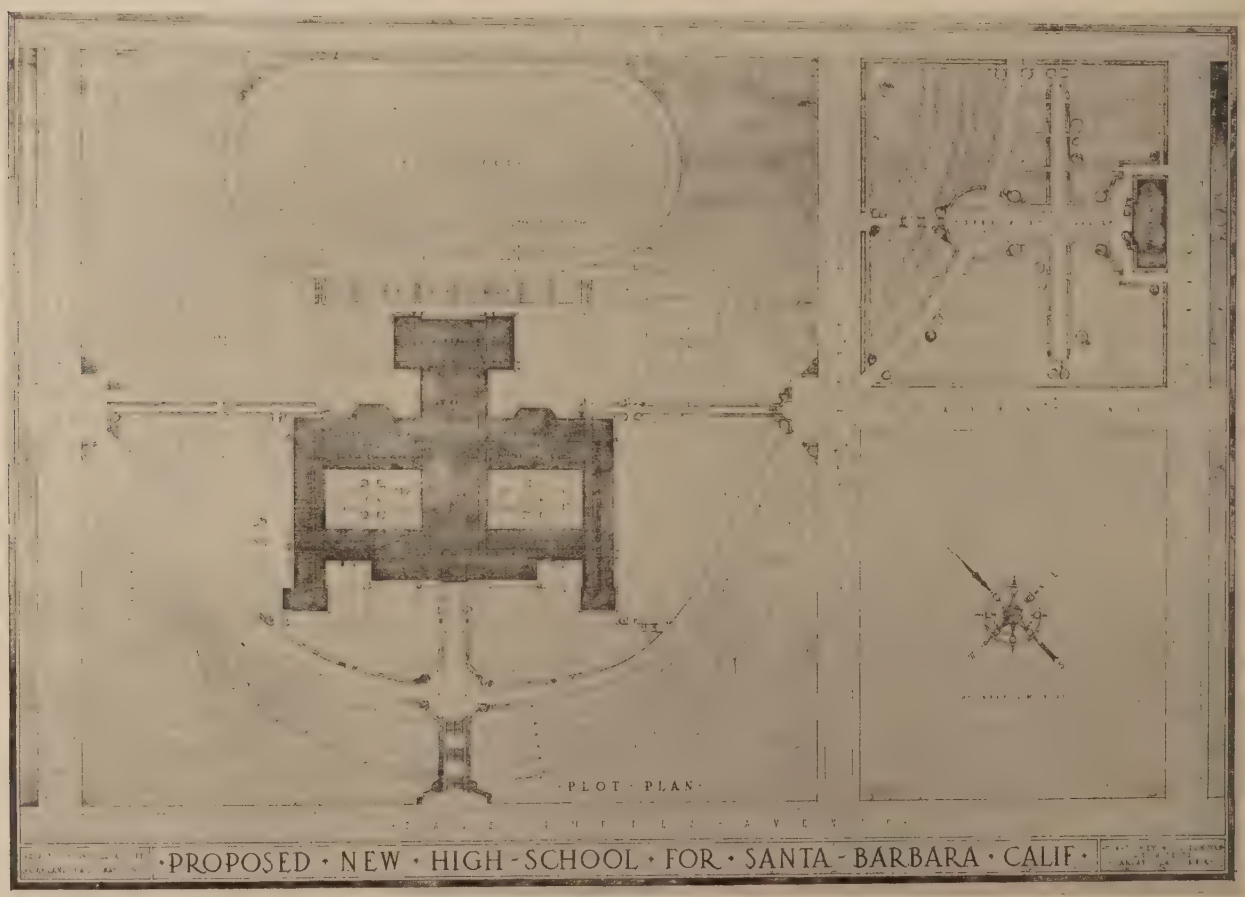


Fig. 6.

Messrs. Perkins, Fellows & Hamilton, Architects.

FIG. 7. — ATHLETIC FIELD, NEW TRIER TOWNSHIP HIGH SCHOOL, KENILWORTH, ILL.

factory for school playground purposes. Hockey is played on this field.

12. Sandbox for Boys, equipped as number 1.

13. Jumping-pit, filled with shavings.

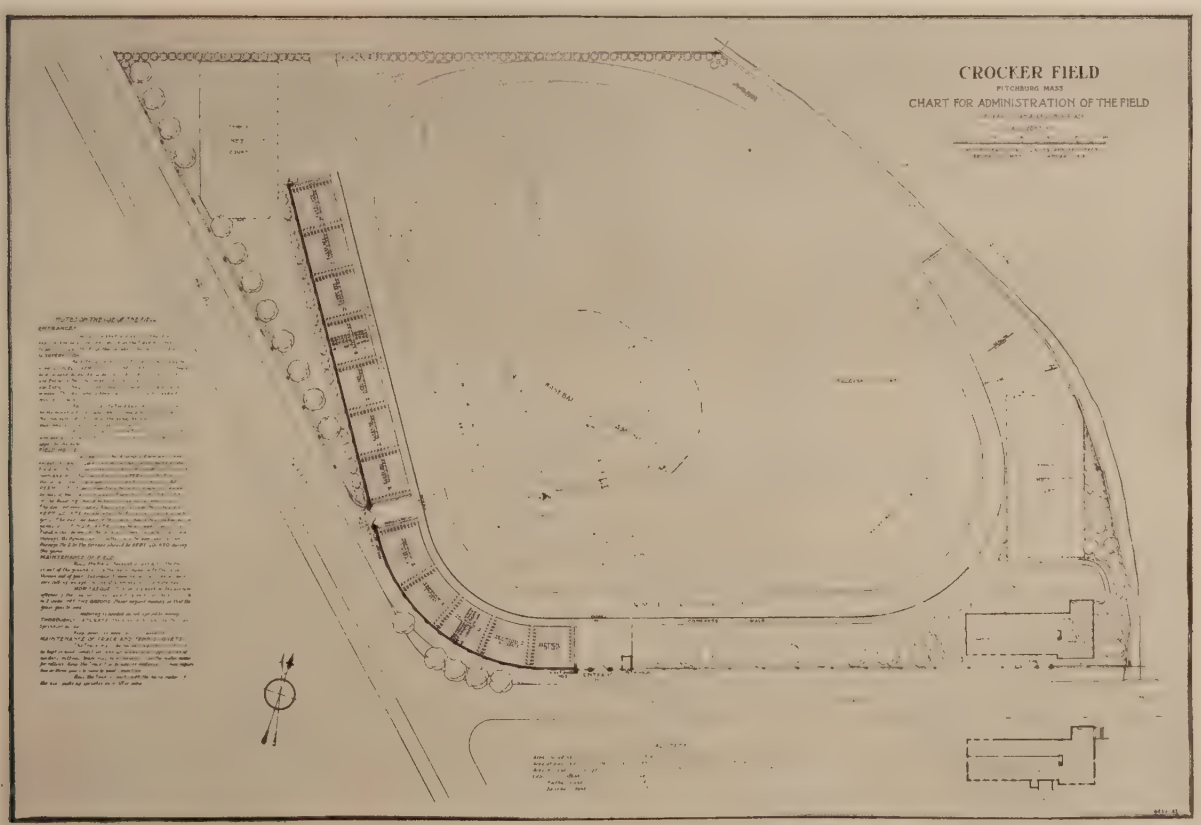
14. Wire Cage Backstop for baseball.

15. Open Pergola Porch, covered with canvas in the summer time, which affords a place for small children to hold club meetings and enjoy diversified play.

Area marked X is an oil macadam composition. It makes an excellent surface for court games.

Surface marked Y is covered with crushed-rock dust. It makes a good baseball field, but is a little too hard for football, — sandy loam would be better.

Figure 5 shows the group plan of the Technical High School, Oakland, California. This plot includes 14.85 acres.



Messrs. Olmsted Bros. — Landscape Architects.

FIG. 8.

Messrs. Olmsted Bros., Landscape Architects.

FIG. 9. — CROCKER FIELD, FITCHBURG, MASSACHUSETTS.

Messrs. Olmsted Bros., Landscape Architects.

FIG. 10. — FIELD HOUSE, CROCKER FIELD, FITCHBURG, MASSACHUSETTS.

FIG. 11 A. — CROCKER FIELD, FITCHBURG, MASSACHUSETTS. *Messrs. Olmsted Bros., Landscape Architects.*

FIG. 11 B. — CROCKER FIELD, FITCHBURG, MASSACHUSETTS. *Messrs. Olmsted Bros., Landscape Architects.*

CHAPTER II

ARCHITECTURE, PLANNING, AND CONSTRUCTION

By John J. Donovan, B.S., *Architect*, A.I.A.

The Motive of American School Architecture. Formation of the Plan. Correlation of Departments. Planning the School of the Future. The Exterior Composition. Standardization. Legislation. Construction. Materials. Inspection. The Architect and His Service.

Motive of American School Architecture. — There is nothing more impressive or hopeful in American democracy than the devotion of the people to education. Nor is this devotion confined to those who have enjoyed its enrichments. Even in the humblest homes unlettered parents will be found to have a fixed desire for the educational welfare of their children. Sacrifices in personal comforts of all but the means of mere existence are made in order that the family may have the opportunity of receiving not simply the fundamentals of learning, but the training of the university as well. And the devotion of the wealthy is no less impressive. For the great progress of education is due in large measure to the interest in education shown by men and women of affluence. Universities, colleges, academies, and often the public schools could not have fulfilled the educational wants of the nation, had it not been for the many magnificent endowments, for the promotion of learning and the development of character, placed at the disposal of education by these public-spirited people.

Education is the common meeting-ground for all classes, creeds, and races, where the small bothersome misunderstandings of life vanish; and nowhere is this more evident than in American school life. The greatest tribute of justice that can be paid to the nation is that its laws first demand that its youth shall receive the fundamentals of education, and then it presents the widest opportunities for its humblest citizen and resident to proceed in acquiring unlimited learning.

With such a foundation, it is no wonder that the architecture of American schools and institutions of learning has advanced more rapidly than that of any other field of the profession. Unconsciously the spirit has been to represent truly this national devotion to education in the architecture of public schools. If progress in education is observed from the time when it was dispensed within the small box-like building, with its poorly lighted and badly ventilated rooms, to its present expanded and still expanding status, as carried on within the modern complex structure completely equipped and embracing all facilities for education, health, and safety, it will be seen that architecture has kept abreast with each succeeding step of the educational program, in which the course of studies has become more and more extended to meet the requirements of the industrial, commercial, and social life of the nation.

Notwithstanding this expansion of the curriculum and the consequent complexity of the building and equipment, it is gratifying to note that the architecture of the school has remained simple and direct. This is truly a hopeful sign. For as the nation advances in its development and maintains its virility, the demands for education will always outstrip the supply. And the burden of taxation so willingly borne as a responsibility to posterity and good citizenship is that much lightened when the merit of the architecture is based on good planning, beauty of form, and dignity of proportion. Ornamental embellishments serve no purpose. They do not represent the character of the school or of the people, and happily their use is rare in American school architecture. Just how much credit for this is due to the influence of the work of Wheelwright, Ittner, Snyder, Perkins, Hussander, Guilbert, Betelle, Packard, and to the innumerable unheard-of men who have contributed isolated examples, and to the influence of the broad-minded, alert, and discerning leaders of education, is difficult to measure at this time. But it is recorded in their examples of school architecture that these men, by their serious study of the problem and their good sense for simplicity in composition, have led the way in school architecture toward possibilities which have clearly exemplified the people's devotion to education and their appreciation for simple, substantial structures.

Formation of the Plan. — The proper understanding of the school problem might be said to have passed its first stages. While what has been accomplished in the

Mr. Wm. B. Ittner, Architect.

FIG. 12.—CLARK ELEMENTARY AND SOLDAN HIGH SCHOOL, ST. LOUIS, MISSOURI.

Mr. Wm. B. Ittner, Architect.

FIG. 13. — BRYAN MULLANPHY ELEMENTARY SCHOOL, FRONT VIEW, ST. LOUIS, MISSOURI.

last two decades has been remarkable, it will be greatly surpassed in the future. With a comprehensive knowledge of the pedagogical organization being more generally acquired by the architectural profession, the prospect is bright for good planning of school buildings. There is an axiom in the science of building that a good plan should produce a good exterior. This, of course, is subject to the limitations of training, skill, taste, and competence of the architect. But it is none the less true that the plan must be of primary importance. The correlation of rooms within each department and the correlation of departments within the school is all-important if the school is to permit of being well administered. In factory planning, the essential factor is the routing of material along the most direct and economical channels. In school planning, the routing of the human material is the essential. Rooms which can serve more than one purpose should be planned to do so. For it is by such practices of economical planning rather than by the use of cheap materials that real economy can be accomplished.

Within the last decade there has been a strong tendency to link the school and the community together by providing separate rooms for community purposes, such as clubrooms, small libraries, etc. This movement is accomplishing its purpose, for out of it is growing a valuable connection, namely, the continuation school. The close relation between the school and the community must be fostered if education is to prosper; but instead of devoting valuable space in the building for occasional use, rooms such as the teachers' rest room, the library, the assembly hall, or the music room should be the meeting places of the community clubs.

Every facility should be made for educational work, and every dollar spent should have its worth expressed in the educational, hygienic, and structural features of the building. When it is considered that even with the strictest economy in planning only fifty per cent of the total floor area can be used for instruction while the other fifty per cent is used for corridors, stairways, entrances, and rooms and areas related to instruction rooms, it is evident that judgment must be exercised in giving up space for other than that for direct instruction. This, however, should not prejudice the reader against such rooms as assembly halls, swimming-pools, playrooms, etc., for these are just as essential to the development of the child and the community as the classrooms themselves. The school of the future will

not be complete without them; but their location with relation to each other should be planned to avoid duplication of equipment and plant. For instance, the toilets, showers, dressing-rooms, etc., for the play-yard activities should also serve for the swimming-pool, the gymnasium, and the indoor playrooms. The dressing-rooms for the assembly-hall stage should be planned for use by the music department for private instrumental instruction. In fact, all the rooms throughout the school should be considered as having possibilities for extended use into school activities beyond their primary purpose.

The plant and equipment of the day school must be fitted and adapted to the work of the continuation school, so that rotation of students may be accomplished without friction or waste of time or energy. In many cities the continuation school periods begin at 1:00 P.M. and extend to 10:00 P.M. It is not unlikely that the hours of work for this branch of school education may extend from 7:30 A.M. to 10:00 P.M. Students enrolled in the continuation school enter and leave the building at all hours, consequently, the plant should be as flexible as the organization in meeting the requirements.

Mr. Wm. B. Ittner, Architect.

FIG. 14. — BRYAN MULLANPHY ELEMENTARY SCHOOL, ST. LOUIS, MISSOURI.

Correlation of Departments. — The various departments of the school are treated in separate chapters because of the importance of having correct and definite data embracing their organization, planning, and equipment. Their correlation only will be discussed here.

It will be found advantageous if the commercial department is placed near the administration offices, as they have much in common. The shops should be isolated from the study and recitation rooms, on account of the noises attendant to their operation. The drawing department should be near the shops, as all advanced shopwork should be performed from working drawings. If these two departments are adjacent, convenience will result. Possibilities for wide expansion should always be made feasible in planning for shops. The household arts and the science departments should also be near each other; particularly should the chemistry laboratories be available for use by the students in cooking. The chemistry of foods is a part of the curriculum of household arts in modern high schools. The academic department and the library are almost a unity, and wherever located, possibilities for expansion and easy growth should be considered from every angle. For, as enrollment increases, this department is the first to feel congestion. Locating the assembly hall, the gymnasium, the swimming-pool, the showers, and the play-yard accommodations should have reference to free accessibility by the public. These divisions of the school plant should be arranged so that if found desirable or necessary, the remainder of the school may be closed off. As a general rule, the heating plant should be closely connected with the shops and apart from the main building. This will serve a double purpose in providing certain instruction to the student in mechanical installations and at the same time increase the safety of the building and its occupants.

Planning the School of the Future. — The school of the future, having the last decade of progress in education for its foundation, will have to be proportionate in plant and equipment to meet the needs of each community for the great post-war period of education. The physical and scientific requirements of the World War (1914–1918) have precipitated a feeling for an intense and constructive movement for greater diffusion of educational training in the professional, social, industrial, and commercial fields of endeavor. Business, industry, agriculture, and the other arts of life are no longer independent of the school. Nor is the school an isolated institution, occupying a definitely limited period in the life of the individual. That belief now lies in the background of the history of both education and industry. Research and applied science have received an impetus never before experienced or equaled, an impetus which

gives to these two important branches of education a higher standing of importance.

It is also through the school that the more complete nationalizing of the immigrant and his children will be brought about. This movement is well under way at the present time, having received its impulse from the spirit of patriotism for America so magnificently exemplified by the foreign-born citizens during the war. A tremendous effort towards national homogeneity and common interest is bound to result from it. This will directly benefit education and the state. Readjustment rooms used for the study of English and literature. Attempts, sometimes partly successful, have been made to give these rooms a character of early English Tudor architecture. These sporadic efforts have had their limitations and difficulties on account of the fenestration necessitated by the modern requirements for good natural lighting. Except for the development of the library and the arrangement of the dividing partitions so that floor areas of rooms may be easily altered to expedite flexibility in administration, this department of the school plant is likely to be subject to very few modifications

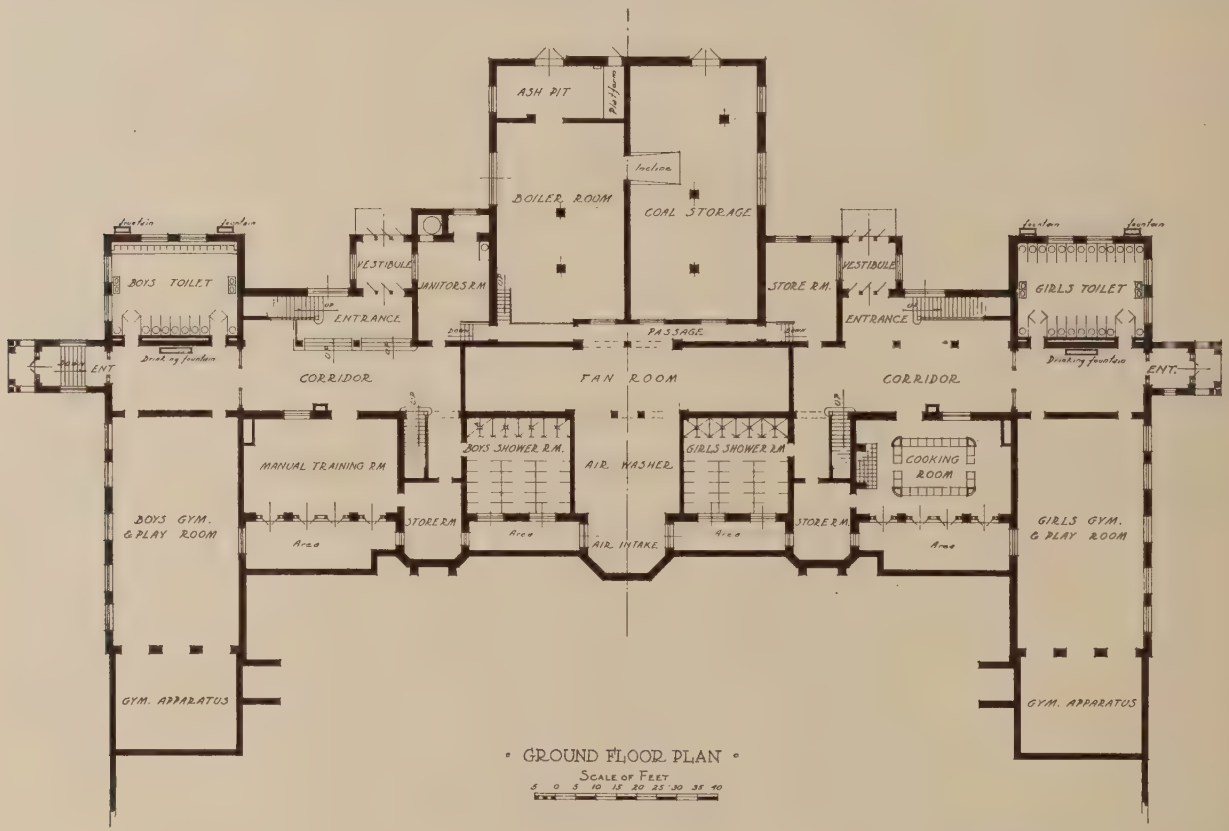


FIG. 15.

of the school plan necessarily will follow. Just where and how is problematical for the moment, but most likely the greatest development will take place in the household, industrial, and commercial departments of the school plant.

The academic department, which teaches the studies of mathematics, languages, English, history, civics, and geography, — the subjects of culture and the foundation for all other forms of education, — has stood the test of time without much change in the physical requirements of its rooms beyond enlargements of area and improvement of the hygienic conditions. However, certain refinements have already taken place in the design of other than providing sufficient well-lighted, healthful rooms for study and recitation.

The departments teaching the sciences, industrial arts, drawing, household arts, and commercial studies are most subject to change in their curricula, plant, and equipment. And to meet the changes, it is necessary for the school to draw from the ranks of industry, able leaders to assist in the planning and instruction. No longer will it do to assign vacant rooms and simply designate them as shops or laboratories. Each room, before the drawings have passed beyond the preliminary stages, must have its equipment carefully shown, properly located, and tested in the abstract for efficiency and adequacy.

Attention should be called to what all this means in the planning and architecture of the school of the future. Undoubtedly, the high school will take on the aspect and character of the university, and function for the community as the university now functions for the state. Instead of many small and distinctly exclusive high schools, such as the classical, the commercial, the technical, the vocational, etc., etc., the people and their representatives, boards of education, will see the light of wisdom and group all these separate schools under one, two or three plants, according to the size of the district or city. This will make for economy in cost of management, housing, and maintenance, and will broaden the scope of the educational staff. Likewise, it will prove attractive to able men and women engaged in teaching to strive for greater leadership and high social standing in the community. In the long run, it will be found less expensive and more advantageous to have one large plant rather than several small ones. In well-developed cities the high school, costing as much as a million and a half dollars and even more, will in the very near future be not uncommon. Valuable service will be rendered if all school plants are planned for unrestricted growth. This requires a thorough knowledge of the school and a vision of the future. The greatest waste is to build so that additions cannot be made and that plants must as a result be abandoned after thirty or forty years of use. Bond issues extend to almost that time, and it is unfortunate if the plant has to be discarded shortly after payment of the last installment.

The problems surrounding the planning and architecture of the elementary and intermediate, or junior high school, are no less important than those of the inclusive high school, although not so complex or numerous. But it is in the serious thought and study of these two plants that rests the hope of the nation. Indifference to the planning, sanitation, heating, and ventilation for these fundamental education buildings has given way to the purpose of having them adequately designed to meet their needs. It is expected they will be charmingly simple in their architecture and inviting in their appearance and surroundings. Just as their curricula are the foundations for higher education, so, too, is their architecture the foundation for greater development of American school architecture. Of late, in certain sections of the country, there has been a tend-

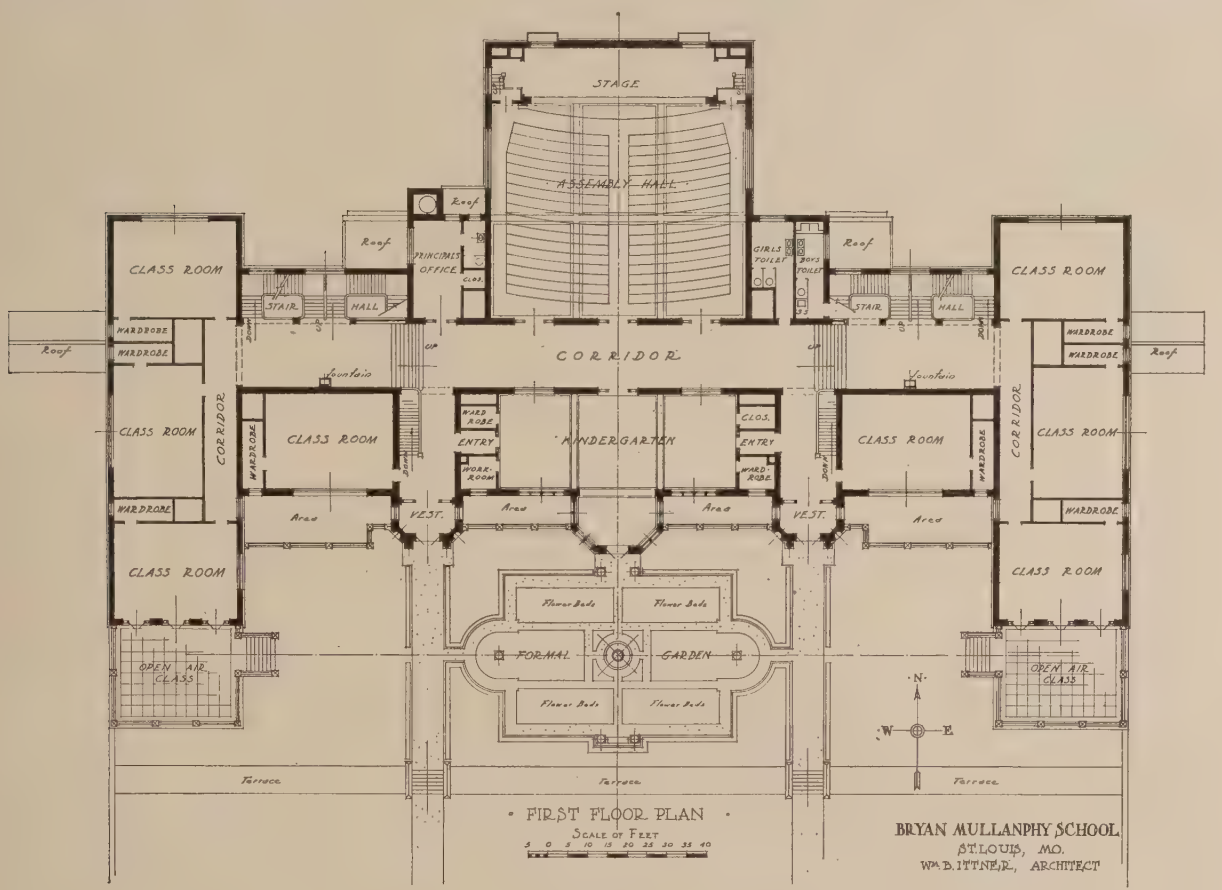
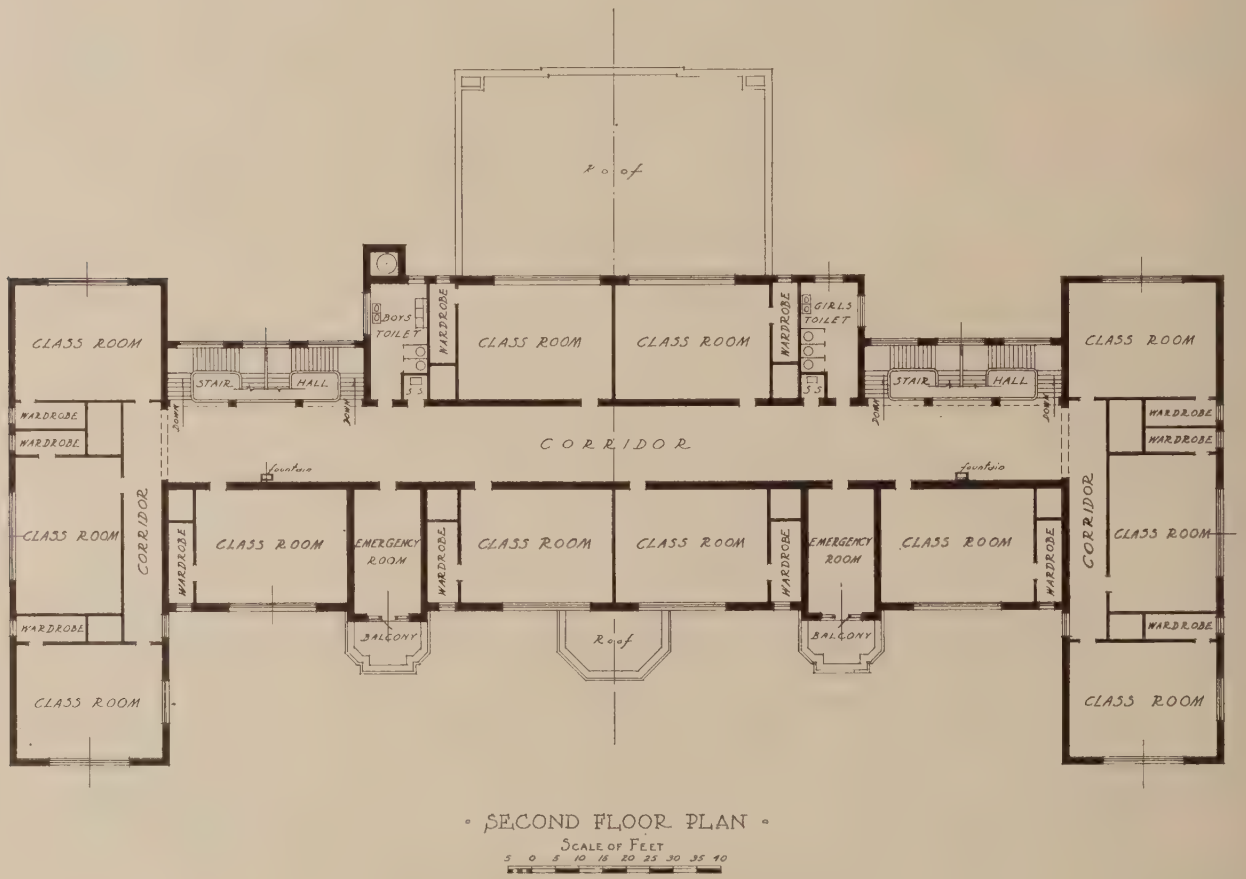


FIG. 16.

ency to develop a compact, fixed plan which has been influenced by desires for economy. Desirable orientation and natural ventilation of rooms and corridors have necessarily been sacrificed in many instances in favor of compactness. Children of the age attending these schools require the most favorable hygienic conditions in order that their physical assets may be conserved to the fullest degree.

The Exterior Composition. — However good the plan of a school may be, or whatever the excellence of its capability for administration and instruction, unless it is accompanied by a pleasing composition of the exterior, it will soon lose its prestige and be forgotten. One of the important functions of school architecture is to sell education to the public. This is accomplished by making attractive that side of education which the



BRYAN MULLANPHY SCHOOL
ST. LOUIS, MO.
WM. B. ITTNER, ARCHITECT

FIG. 17.

The writer is of the opinion that the open type of plan of the one-, two-, or three-story buildings is most conducive to good health, and that economies of space obtained in the compact scheme may be offset in the cost of construction of the open type. Certainly more sunshine is possible with the latter type of plan. But rather than prejudice the minds of those responsible for the erection of schools, it should be clearly understood that each problem is distinct and separate in itself; and its plan and construction should be based on the conditions governing its study.

public see most. So much has been written and said about the educational value of good architecture to the community, that it is needless to repeat here what has been so thoroughly propagated to influence civic interest for good public buildings. But appropriately something may be mentioned about the educational value to children and students of housing them in buildings having merit in form, proportion, and good taste both without and within.

Much effort is made within the school to teach children to draw accurately and freely, to paint with oils

Messrs. John J. Donovan and John Galen Howard, Associate Architects.

FIG. 18. — EMERSON ELEMENTARY SCHOOL, OAKLAND, CALIFORNIA.

Messrs. John J. Donovan and John Galen Howard, Associate Architects.

FIG. 19. — EMERSON ELEMENTARY SCHOOL, OAKLAND, CALIFORNIA.

and water-colors, to comprehend proportion of areas and figures, to understand the history of art and civilization, and to master other subjects which lead to the realms of art. The motive prompting this work is not that a livelihood will be made from such brief training, but that the child will be trained to have a sense of appreciation for the beautiful which he may express in other forms of life's activities. Therefore, is not this appreciation greatly enhanced and fostered if the building and its appointments are executed so that the mind, at

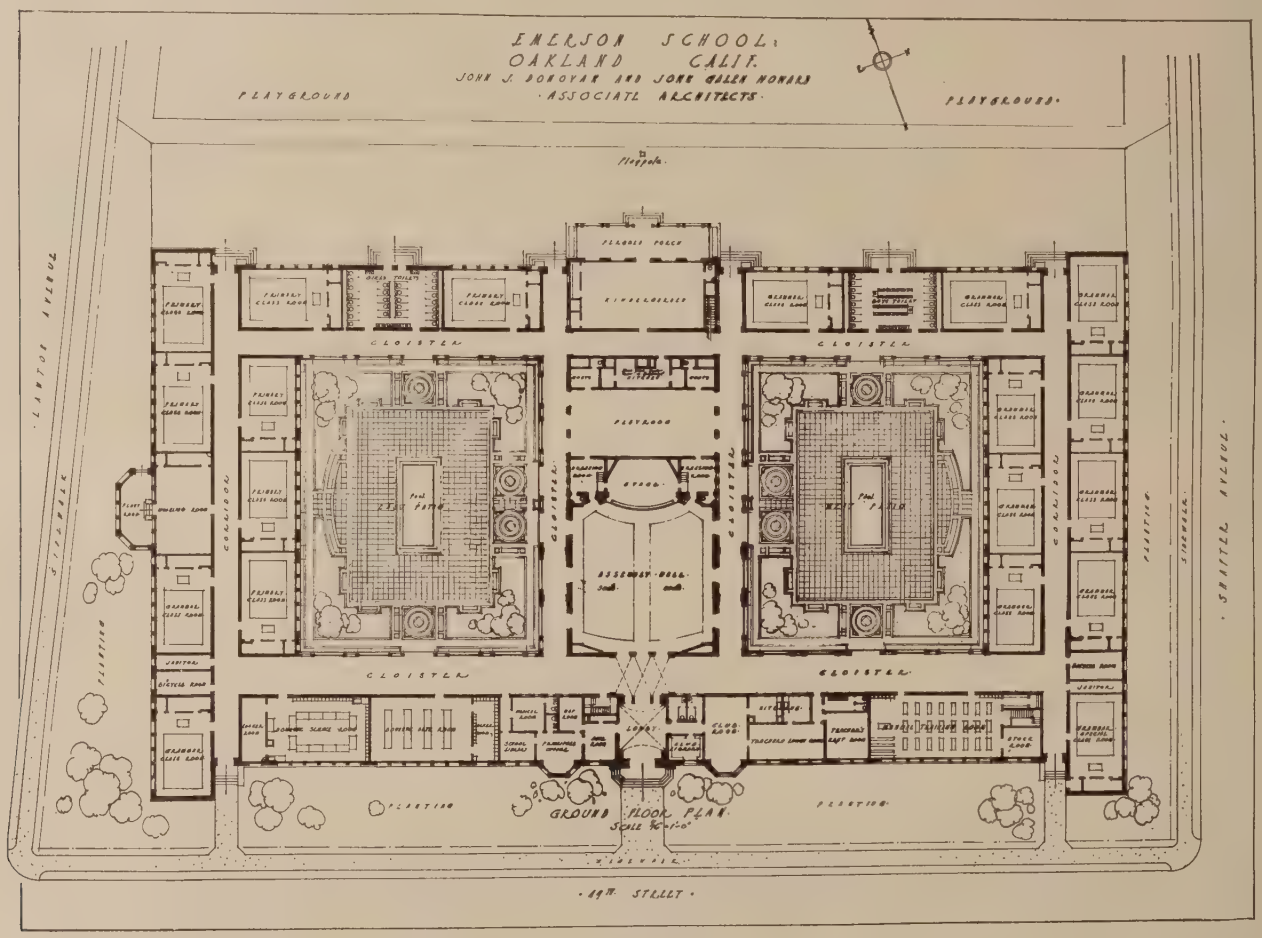


FIG. 20.

forced to work in mills and factories at an early age and by children having to attend schools whose architecture paralleled that of the jail or the factory. How often has the boy of sound mind wished dire happenings to the school, which meant nothing more to him than a place of confinement and restriction! Much of this ill-will is traceable to the forbidding impression of the school building, with its uninviting exterior and its dark and poorly ventilated corridors and rooms. Happily the renaissance in school architecture which has

its impressionistic age, may have good examples constantly before it? Set a child to draw a picture of a house, and immediately he will attempt to reproduce his impression of his own home, showing that he has been influenced entirely by his environment.

Prisons and jails are built to express severity and confinement. To see nothing else but their heavy, crude walls and buildings is a punishment almost equal to the restrictions of freedom within them; and the mental depression caused by the severity of their architecture has its own discouraging influence. A similar influence has been felt by the child whom circumstances have taken place during the last ten years has modified this feeling of the child towards the school. The provision of better facilities for play has had much to do in changing the child's attitude; but the charm of simple, pleasing architectural forms, together with grounds graced with appropriate foliage and lawns, has had its influential effect upon the adult as well as upon the pupil.

The efforts of those interested in child welfare and in the future of the nation are directed towards extending and prolonging the period of early education. If this movement is to be successful and profitable to the state,

FIG. 21. — EMERSON ELEMENTARY SCHOOL, OAKLAND, CALIFORNIA.

it must meet with the fullest coöperation on the part of the child, whose voluntary attendance is worth more than his coming through fear of the law. And to enlist this coöperation, it is fundamental that the school in its appearance shall be attractive to the child.

This can be brought about in no better way than by erecting simple, pleasing architectural buildings at the very beginning for the elementary schools. Here the small child receives his first impression of the school and the world, an impression not subject to early change, as he is likely to attend the same school for a number of years. Consequently, the child should be the motive for the architecture of this grade of school buildings, and not some time-honored example of a great period of development in architecture. The composition should reflect the spirit, quietness, and refinement of a good home. A transition takes place in his life as soon as the child first attends school, and that transition should be accompanied with delightful discoveries of new forms and environments pleasing to the senses. Until recently there has been too much effort to show how much architecture could be put into even the simplest of problems. Meaningless domes, bombastic use of the orders, wonderful creations of the monumental misapplied to the unpretentious, have had their day in the development of American school architecture, and it is to be hoped they are never to return.

The word "classical," with all its magic, will not influence the intelligent layman to connect modern school design with that meaningless phrase as applied to architecture. It is effeminate to talk of styles of architecture, and slavish to force their forms into a well-organized plan. Each problem should have an architecture or composition of its own in keeping with the plan, the locality, the materials accessible, and the many other factors influential in its study. If the school is first viewed as a technical problem and solved in plan from this standpoint, then, with the use of good materials and simplicity as the main motive, there will be no question about the successful progress of school architecture. What has been said about the architecture of the elementary school is equally applicable to the architecture of the high school. Here, however, the child has advanced to and beyond the adolescent age when its mind is most confident and critical. And as the impressions of the elementary school should be influential to attract the child to school life, so too should the high school exert influence to impress upon the student the value of dignity, proportion, and good taste. As the child should be the motive for the architecture of the earlier school, likewise the student should be the motive for the architecture of the advanced school. The high school is the last seat of learning to be attended by the greater number of students enrolled within it, and, if for no other reason, it should present them with visions of accomplishments in life. Pride in country and in citizenship is dependent on the creative power of the people as well as upon the laws guaranteeing liberty and social possi-

Messrs. John J. Donovan and John Galen Howard, Associate Architects.

FIG. 22. — EMERSON ELEMENTARY SCHOOL, OAKLAND, CALIFORNIA.

bilities. The high-school student is quick to perceive the merits of this creative ability. Therefore, if our schools are to fulfill their functions, their outward appearance should have the character, repose, and presentation befitting the important work going forward within.

Standardization. — In the chapter on elementary schools, it has been pointed out that standardization is likely to lead to stagnation. This is quite true unless standardization is applied only to the details of construction, which may be standardized without restricting the general development of the administration and instruction within the school. Educational methods are rapidly changing, and will change just as long as progress is made. When they cease to change, stagnation and then decadence follow. Consequently, the building should be constructed to permit the greatest flexibility in arrangement of rooms, even after the building is completed, so that the construction will always be adaptable for modification to the school organization. In a recent report to the New York City Board of Education, on Public School No. 29, Mr. C. B. J. Snyder, Architect, pointed out many means and ways towards standardization of the architectural details within the building, for instance that the ventilating ducts enter the classrooms from the ceilings of the corridors, so that dividing partitions may be changed at will. He also prepared the specifications so that different systems of construction and materials, equally good, may be optional with the contractors.

Such standardization is commendable, but whenever standardization takes the form of limiting freedom in design and composition, or the endeavor to make the community fit the school instead of vice versa, then standardization is nothing short of a prolonged menace. If the æsthetic and educational value of a well-designed exterior is to be disregarded and schools are to be erected like so many factory buildings, then standardization some day is bound to reflect on its followers. Or if plans are to be standardized, and fixed forms erected repeatedly, then progress in school planning will cease. However, duplication of types at a particular period, and for the same grades of schools operating under similar conditions in the same community, is not at all unfavorable to the progress of school architecture. Such standardization should be handled skillfully and only after the original types have been carefully studied, for there is likely to be duplication of errors as well as of good features. Just how a community would appreciate ten or fifteen schools of the same general plan, and with practically the same exterior appearance, is problematical to

the writer. A final word may not be amiss on the subject of standardization relative to its adoption when applied to buildings as a whole; the orientation, the topography, the size of the different sites, the enrollments, and the social character of the neighborhoods, are matters which should determine the feasibility and the wisdom of duplication of types of school buildings.

Legislation. — The time has arrived when there should be some uniformity in the school-building codes of all the states of the Union. That this may be accomplished, a Federal commission should be created which would carefully study, first the problems of safety and health, and then the details of efficiency and economy in the erection of school buildings. Reports by this commission could be adopted or modified to suit local conditions, by similar commissions or bureaus created by each state. If such bureaus were permanent, with the proper authority to enforce the laws governing safety requirements and health regulations, and if they were equipped with a trained personnel coöperating with the educators of the state and nation, a great and sound progress in school building would ensue. Just prior to the United States' entering the war, the nation was spending more than one hundred and twenty-five millions of dollars annually for the building of public schools. Of this vast sum a very large percentage was spent for buildings erected in states having few, if any, regulations covering the subject; and some of it was spent in states having codes which are rightfully considered drastically precautionary. On the one hand, haphazard planning has followed, while on the other, an unnecessarily wasteful expenditure of resources has been the result, without any particular advantage being gained.

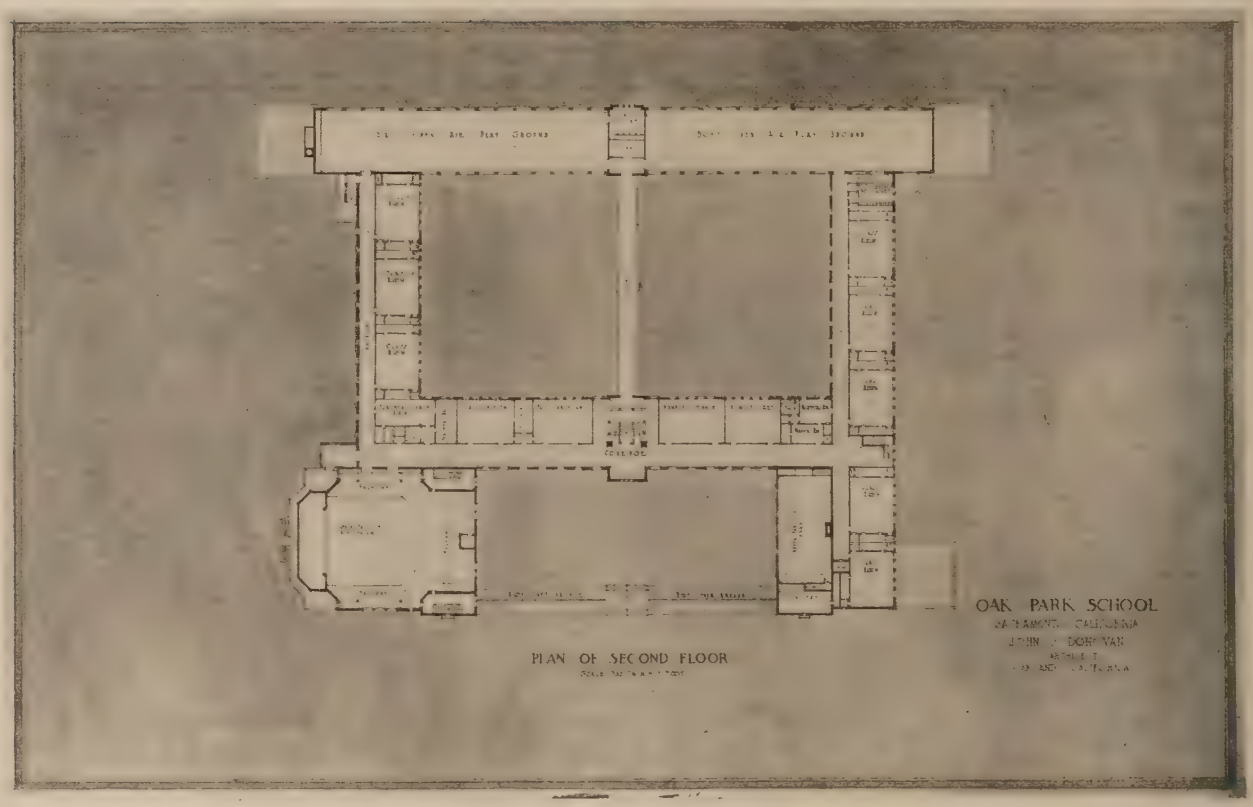
Empowered to pass on all plans and specifications, and free to make recommendations, bureaus of the character suggested would do much towards conserving health and wealth and preventing the erection of poor buildings which could never be erected under proper regulation. It is far more wasteful to plan and build wrongly than it is to plan correctly with too large a factor of safety, although there is no excuse why both extremes should not be obviated. The trend of the times is to expand along broad constructive lines and to conserve in all fields of resource in order that the expansion may be all the more effective.

Possibilities for expansion in education are infinite, and the entire nation is eager to coöperate and take part, but unless it is intelligently and wisely directed and founded on the purpose to conserve human and material resources, unfavorable reactions will unquestionably follow.

FIG. 23.

Construction. — Under this heading it is not advisable to attempt more than a few general statements regarding the use of good materials, the necessity for proper inspection of the construction, the selection of the architect and his responsibility. In the chapter on the "Cost of School Buildings" the different grades of construction are classified, as it was found necessary to define clearly these classifications, since the cost of buildings is closely related to the different types of construction.

Materials. — The distinction between economy and cheapness, as applied to buildings, warrants a clear definition. Economy in building means the avoidance of waste in the design of the construction; the selection of materials which will withstand the ravages of time and appropriately express the architectural design worthy of the citizenship it represents; and the



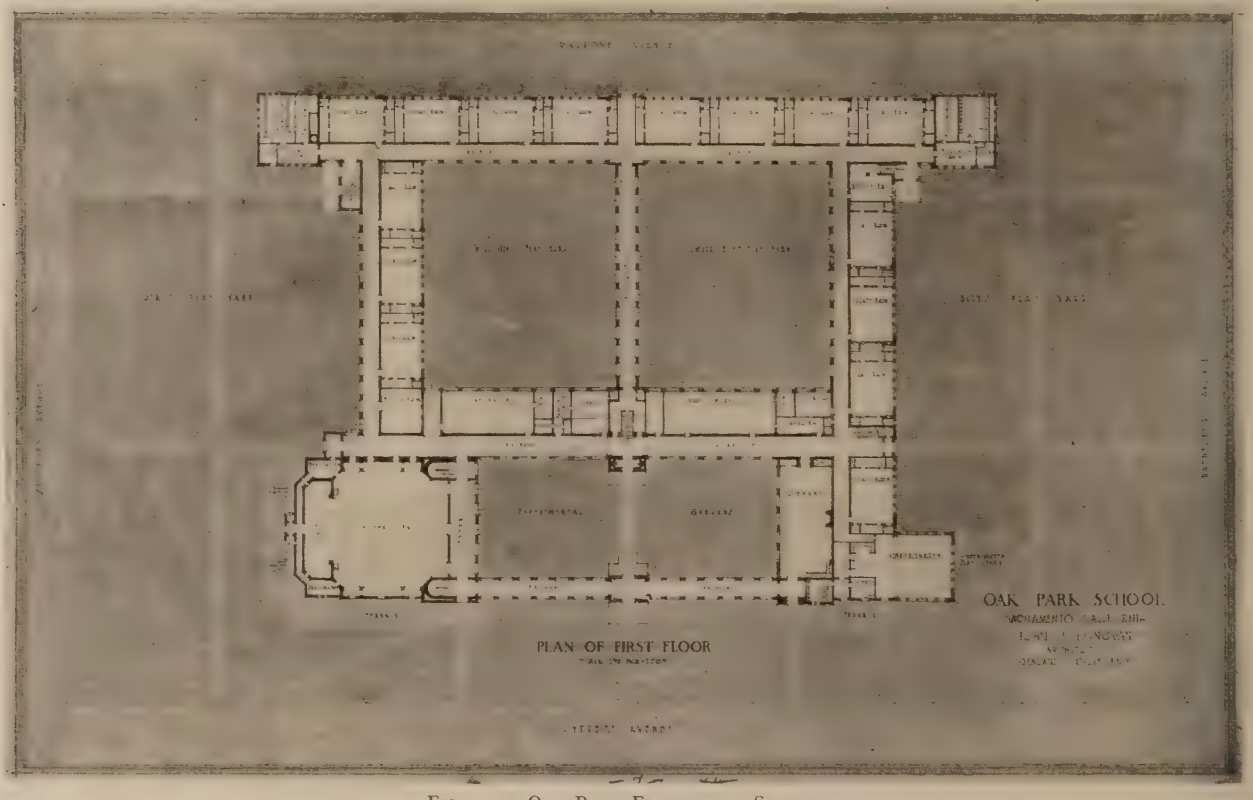


FIG. 24. — OAK PARK ELEMENTARY SCHOOL.

employment of the highest grade of workmanship, fabricating the materials so that after the building is completed the minimum of maintenance charges will follow. On the other hand, cheapness in building implies the use of materials and workmanship of little value, and means that, for the time being, the building will have only the appearance of substantiality. Cheapness also means low cost of construction and high cost of maintenance. Cheaply constructed buildings are perpetual liabilities, and after a short time are worse than worthless because of the cost of maintenance.

The " catch-penny " phrase of building inexpensively means nothing more than the substitution of cheap, temporary materials for those of permanency and character. Unfortunately, attempts are made to beguile the layman into believing that long experience in the trade of handling cheap materials and erecting

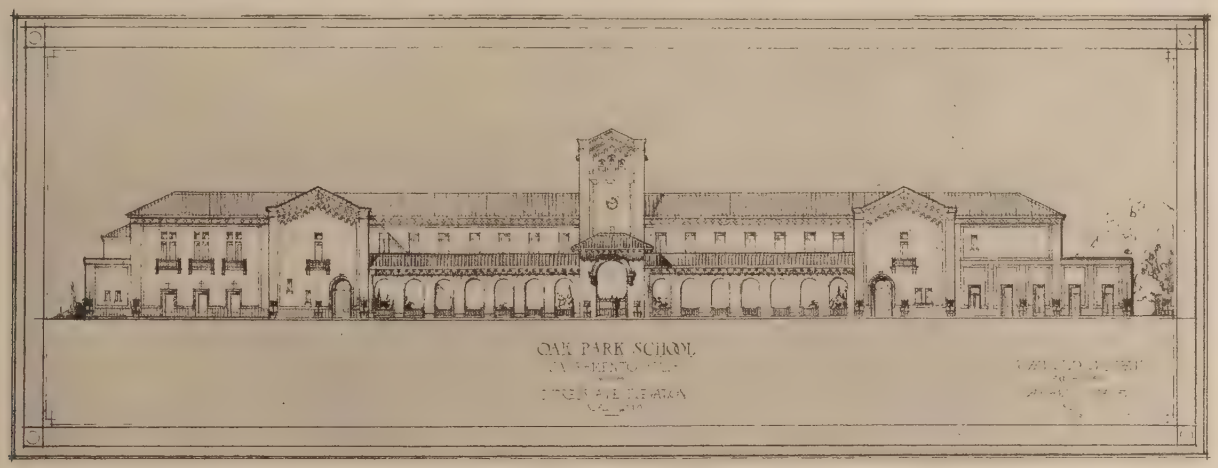


FIG. 25.

temporary commercial buildings has brought about an adeptness akin to cleverness in the use of cheap materials. But it is a known fact that workmen will not take the same interest in their work when using cheap materials as when applying good. The same is true of the public's appreciation of the school buildings erected by public funds. Nothing can be more harmful to the success of education than that people should feel general distrust and dissatisfaction in the character and quality of the construction of school plants. Furthermore, there is a nobility of character and a sense of security in the use of permanent materials which temporary or cheap materials cannot express.

Inspection. — Every school building costing more than $20,000 should have a competent building inspector appointed either by the architect or the board of education, and his salary should be paid directly by the board. He should represent both the board of education and the architect, and it is generally better if he is recommended to the board for employment or dismissal by the architect, as the latter can then be responsible for the proper conduct of the work. The expense of such inspection is justified in every instance and is an obligation on the part of the board as a protection to the city or district. Very often, to drive a good bargain with the architect, boards of education will attempt to impose this expense upon him. Invariably the result is the employment of an inexperienced man who is willing to serve for a compensation far below the value of the services to be rendered, and in consequence the board, the architect, and the contractors are all involved in disputes and misunderstandings. There is no other expenditure connected with the construction of the building more important than that allowed for the proper and constant supervision of the work as it progresses. A competent man will not only see that the work is executed according to the plans and specifications, thereby guaranteeing full value of materials and workmanship, but he will anticipate errors and wastes and often save the board many times the amount of his salary.

The reliable American contractor is about as fine a citizen as any with whom the nation can be blessed. The opposite is true of the unreliable, and inasmuch as public work is generally subject to the freest competition, the successful bidders are unfortunately not always the most reliable. An unscrupulous contractor can easily cause a loss of more than several times the cost of competent inspection. After more than twenty-two years of experience in building operations, the writer is convinced that it would be far better to have the funds plundered directly to any extent, than to have the building cheated to the same amount in the quality or quantity of the materials. In the former case there is every opportunity for just retribution to reach the embezzler, but in the latter the safety of the occupants is involved. In both instances,

Messrs. Guilbert and Betelle, Architects.

FIG. 26. — LAFAYETTE SCHOOL, NEWARK, N. J.
Elevation

the community is the loser. This may be avoided by safeguarding the conditions leading up to the wrong-doing. Briefly, a few points to observe in building inspection are as follows:

Excavation. — See that the proper levels and grades are maintained. All top soil should be placed convenient for rehandling. Trees for future use should be protected.

Concrete Work. — Each batch of concrete should be accurately measured and properly placed, tamped, and protected. All reënforcement should be bent correctly and rightly placed. If the structure is economically designed, the sizes and locations of the steel rods and mesh should be carefully inspected in every column, girder, beam, slab, and wall. The safety of the occupants is dependent upon the inspection as well as the design. All finished concrete and cement work should be kept in a moistened condition for a period of two weeks, except during freezing weather.

Steel. — All work should be plumbed after erection, and all connections riveted tightly. Loose rivets should be rejected, and bolted work should be avoided as far as possible. Unless the steel is inclosed in concrete it should receive two good coats of paint: (*a*) a shop coat, and (*b*) a field coat, of contrasting color applied after all riveting and other steel work is completed.

Masonry. — All brick joints should be solidly filled with mortar properly gauged and the bricks should be in a partly saturated condition when laid.

Carpentry. — Inspection of this branch requires a wide experience. Selection of the lumber is important. Following up the nailing, placing of the grounds for the finish, judging the quality and character of the finish, inspection of the workmanship of the latter, the laying of the floors, and the checking of multitudinous details is a responsibility that can be executed only by a thoroughly competent man.

Plastering. — First of all, the lathing should be closely inspected. Then the mixture and application of the mortar is very important if the finished building is to be creditable to all concerned in the project. All exposed corners should have galvanized metal corner beads, and all angles and wall surfaces should be plumb and true. The thickness and finish of the mortar and number of coats should be clearly specified and carefully checked.

Painting. — The material should be checked as it arrives on the job, and adulteration should never be permitted. Large quantities of gasoline or naphtha on the premises are a sure sign of danger ahead. Each coat should be identified by some mark, and all rubbing of surfaces should be constantly followed.

Hardware. — Only standard makes should be specified, as special hardware and renewals are unnecessarily expensive. However, it should be of good quality, as it is subject to much usage. Brass or bronze should be the metals used for all exposed exterior work. Very often sherardized steel, brass plated, makes a good substitute for interior hardware finish. If brass or bronze is specified, a steel magnet is a good aid to inspection of the make of the material.

Glass. — The thickness and quality of the glass are the principal points to follow in this branch. Only the better grades should be used below a height of eight feet. Above that, it is permissible to allow the use of the less perfect material.

Blackboards are fully covered in the chapter on " Classrooms," and heating, ventilation, plumbing, and electrical work, are also treated in separate chapters, because of the importance of the engineering required for these branches of the special work.

Messrs. Gutlbert and Betelle, Architects.

FIG. 27. — LAFAYETTE SCHOOL, NEWARK
Main Entrance

The above notations are only a few of the many factors involved in the erection of a school building, and are submitted for the benefit of the school superintendent, who may be called upon at times to assume the responsibility of acting as the board's representative on the work.

The Architect and His Service. — Selecting the architect is very often made a difficult task, although it should be a very simple matter. To be sure, the authority of choosing is accompanied with its sense of responsibility, but if any member of a board of education had a legal case at hand, he would not hesitate very long in choosing an attorney skilled in conducting cases similar to his own. Furthermore, if a member of his family required the attention of a physician it would not require much deliberation to select a man in whom he had the utmost confidence. Boards of education are applying these same principles in selecting their architects.

The architect of experience and standing in this field of the profession is aware of the futility of entering competitions, and unless the office is equipped for such competitive work, and makes a practice of entering competitions of every nature, it is found to be an expensive gamble. An occasional competition, however, is often a good tonic for any office, as it discloses the cobwebs and raises the standards of what might be termed academic design. However, every competition requires a carefully prepared program, resulting from the study of the problem by an architect acting as adviser, — one who understands the school and its functions, and can clearly state the requirements and give the proper correlation of rooms and departments. Then it is absolutely necessary that the judges be men of recognized, unquestionable standing in the profession, and chosen for this purpose by ballot cast by the competitors. Furthermore, no competition requiring the submission of drawings should be held until its program and conduct has received the approval of the local chapter of the American Institute of Architects. The writer is fully aware that this is often contrary to the wishes of the average board of education favorable to competitions. Nevertheless, and with every regard for the integrity and honesty of the members of such boards, it is impossible to conduct

Messrs. Perkins, Fellows and Hamilton, Architects.

FIG. 28. — SKOKIE ELEMENTARY SCHOOL, WINNETKA, ILLINOIS.

an honest and fair competition otherwise. Moreover, architects capable of rendering the required service will not enter competitions conducted on any other lines, as experience has demonstrated that they result in nothing but dissatisfaction and unsatisfactory service. Boards of education, too, have found that competitions are unprofitable, and realize that the problem requires special study, which can be more satisfactorily followed if they and their representatives coöperate with the architect from the very beginning of the undertaking.

The practice of architecture is a business as well as a profession. It requires a thorough knowledge of the different building crafts, and a capability to execute the financial expenditures of the client to such a degree of precision that wastes and losses are avoided. It first involves a training in the theory of architectural design and engineering, and then an extended experience in the practice of building management and the application of sound business principles. From this, it is evident that in the selection of an architect the board should choose the man whose work pleases or satisfies them and in whom they can repose confidence.

The building costs one hundred per cent of the contract price. The architect's fee is six per cent of that cost, which is less than one-sixteenth of the total cost of the building. If proper value is rendered in service, it is not possible to measure it either by figures or terms. For the value continues indefinitely. Conversely, improper service bears with it a just retribution in the loss of confidence and repute, unescapable and as unending as the life of the man or the building. There should be no division of the architect's responsibilities. Not only should he be responsible for the execution of the drawings and specifications of which he is the author, but in order to protect the interests of his client to the fullest extent of his capability, he should have undivided authority as to the conduct of the work. Division of responsibility follows division of authority, which opens the way for irregularities and inferior values in the performance of work. In return for the board's confidence, the architect should take every measure to solve the problem in the interest of the client and for the successful advancement of education. This means rendering the best available engineering service as well as competent architectural service.

The trend of the times indicates a mutually happy, confidential relation between the educational and architectural professions, and between the latter and boards of education who represent the public at large. Occasionally, paltry politics or misguided personal friendships on the part of those advisory to boards of education in building programs will counteract progression in the development of the problem and halt solution of the many intricacies which go to make up the whole. It requires years of practice and association for the architect to anticipate the pedagogical requirements and correlate them with the physical or architectural possibilities so that the building squares with the organization of the school and vice versa. The best evidence of this correlation is shown in the splendid character of most of the modern American school architecture.

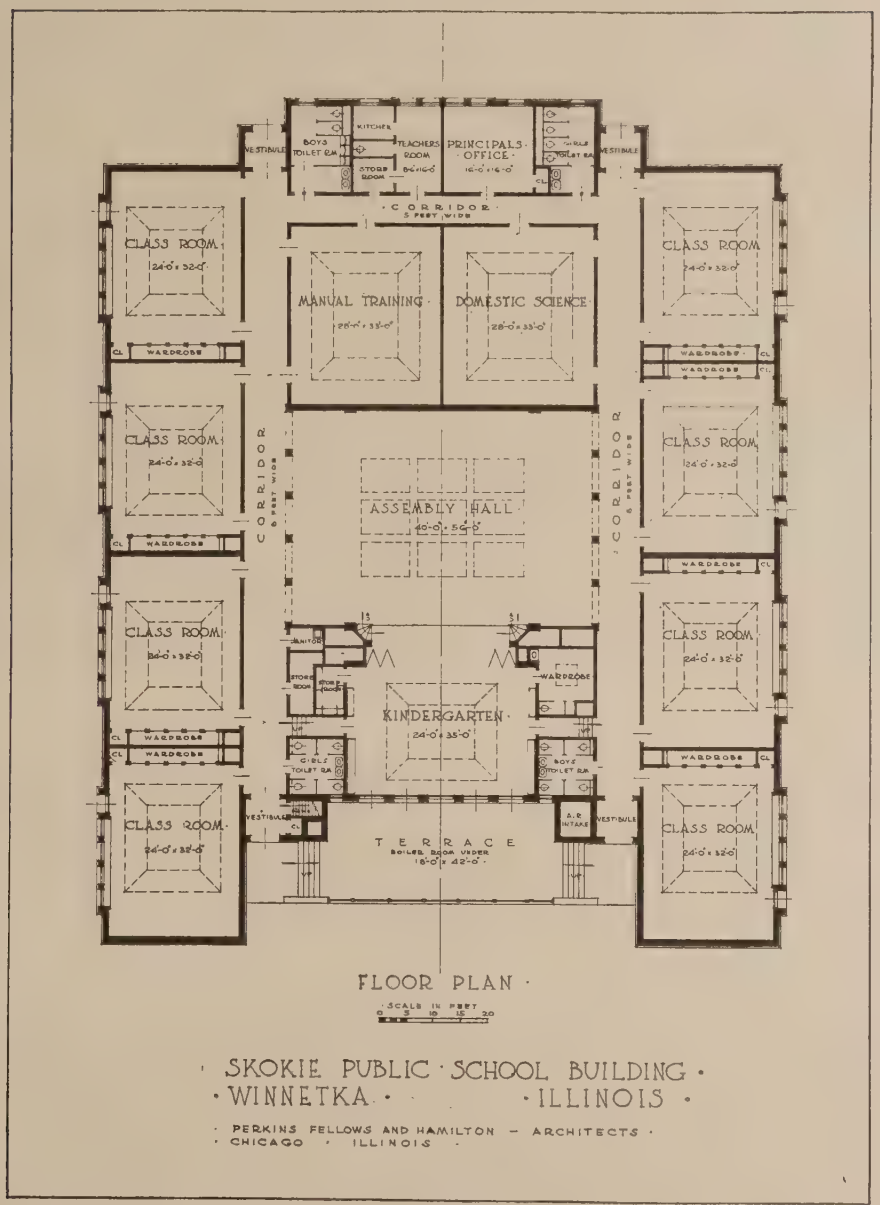

KITCHEN
BOYS TOILET RM
TEACHERS ROOM
STORE ROOM
PRINCIPALS OFFICE
GIRLS TOILET RM
VESTIBULE
CORRIDOR 5 FEET WIDE
CLASS ROOM
MANUAL TRAINING
DOMESTIC SCIENCE
WARDROBE
CORRIDOR 6 FEET WIDE
ASSEMBLY HALL
JANITOR
KINDERGARTEN
TERRACE
BOILER ROOM UNDER
A.R. INTAKE
FLOOR PLAN
SCALE IN FEET
0 5 10 15 20
SKOKIE PUBLIC SCHOOL BUILDING
WINNETKA ILLINOIS
PERKINS FELLOWS AND HAMILTON — ARCHITECTS
CHICAGO ILLINOIS

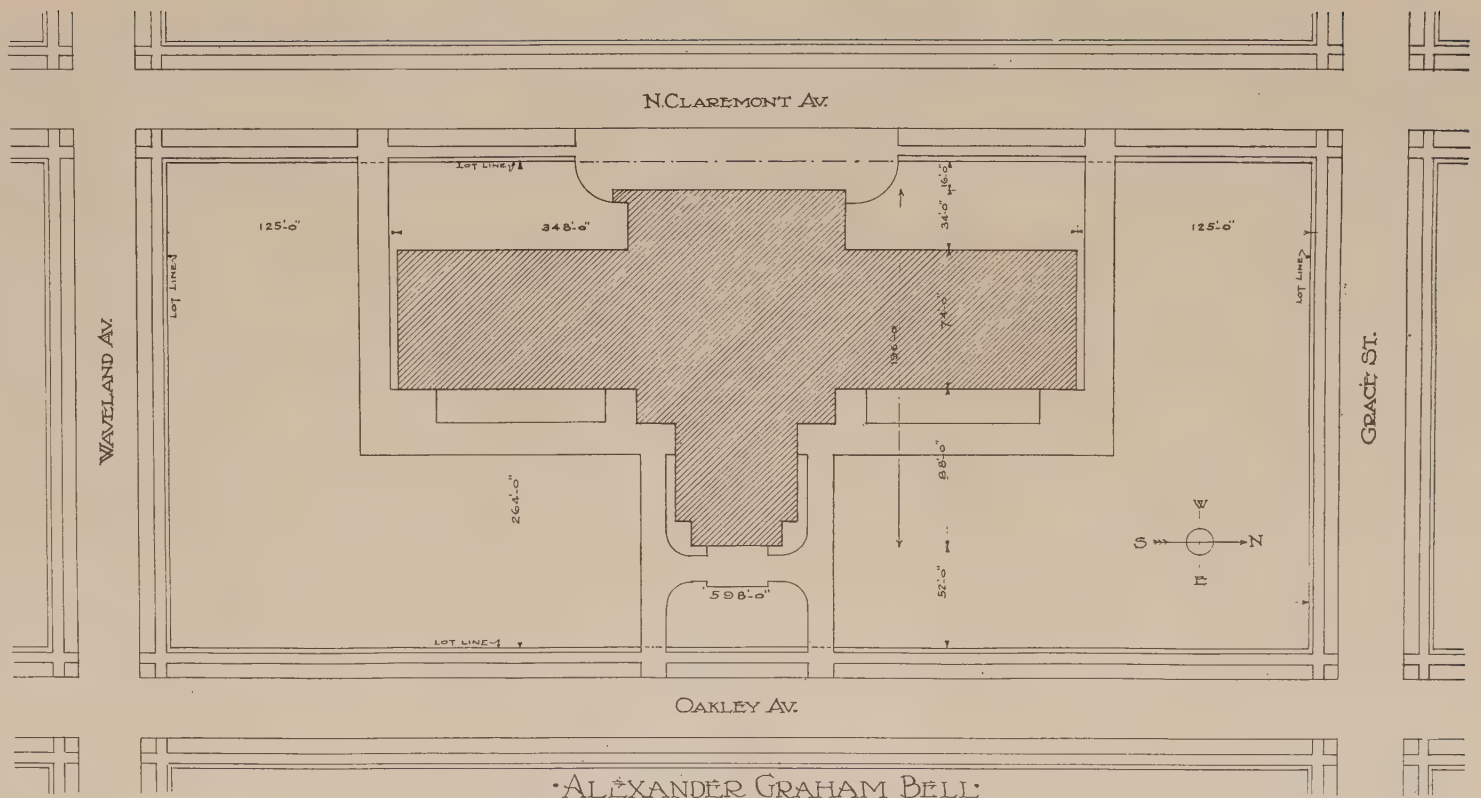
FIG. 29.

Messrs. Perkins, Fellows and Hamilton, Architects.

FIG. 30. — SKOKIE ELEMENTARY SCHOOL, WINNETKA, ILLINOIS.

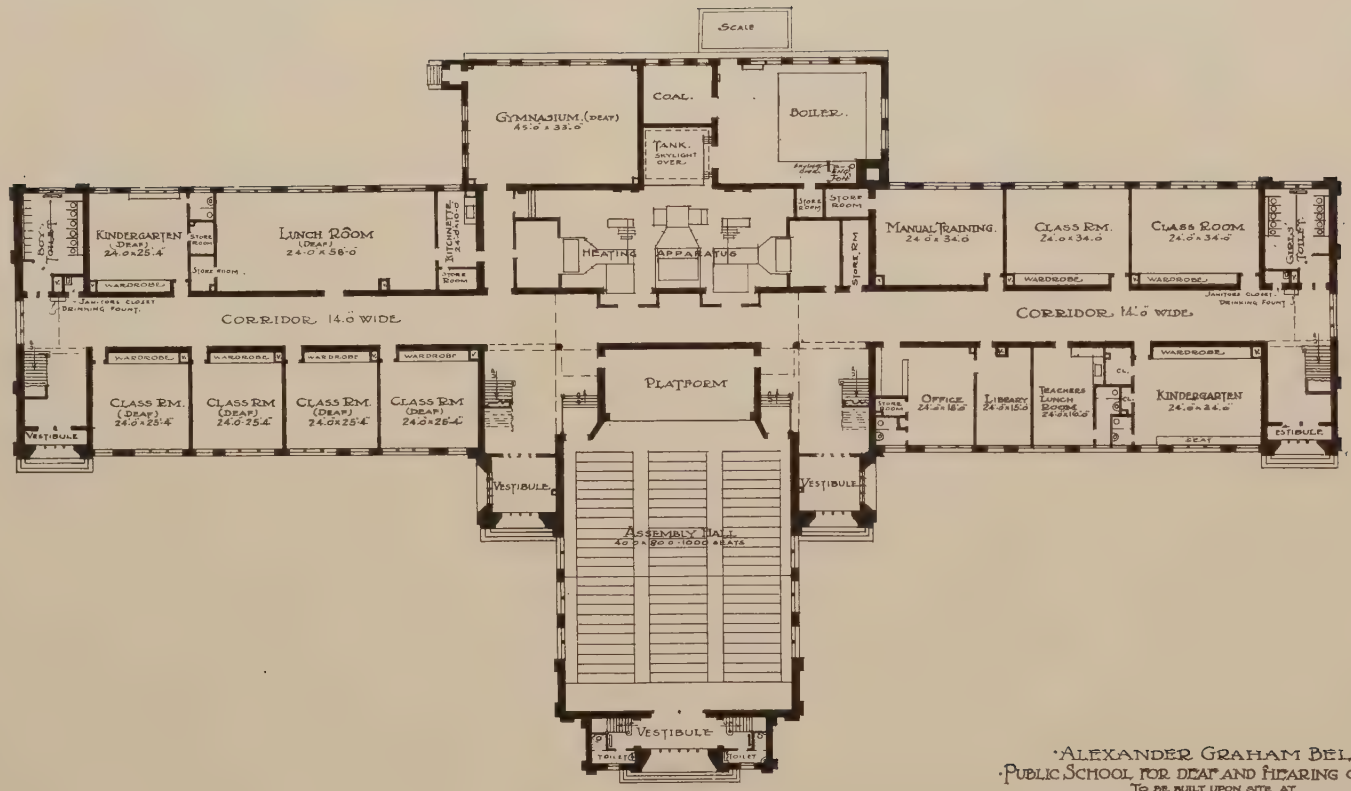
ALEXANDER GRAHAM BELL PUBLIC SCHOOL
OAKLEY AV., GRACE ST. AND WAVELAND AV. — CHICAGO, ILLINOIS.
BOARD OF EDUCATION.
A.F. HUSSANDER, ARCHITECT.

FIG. 31.



ALEXANDER GRAHAM BELL.
PUBLIC SCHOOL FOR DEAF AND HEARING CHILDREN TO BE BUILT AT GRACE ST. AND CLAREMONT AVE. (4)
A.F. HUSSANDER ARCHT. BOARD OF EDUCATION, CHICAGO. SCALE 1/32 = 1 FOOT.

FIG. 32.

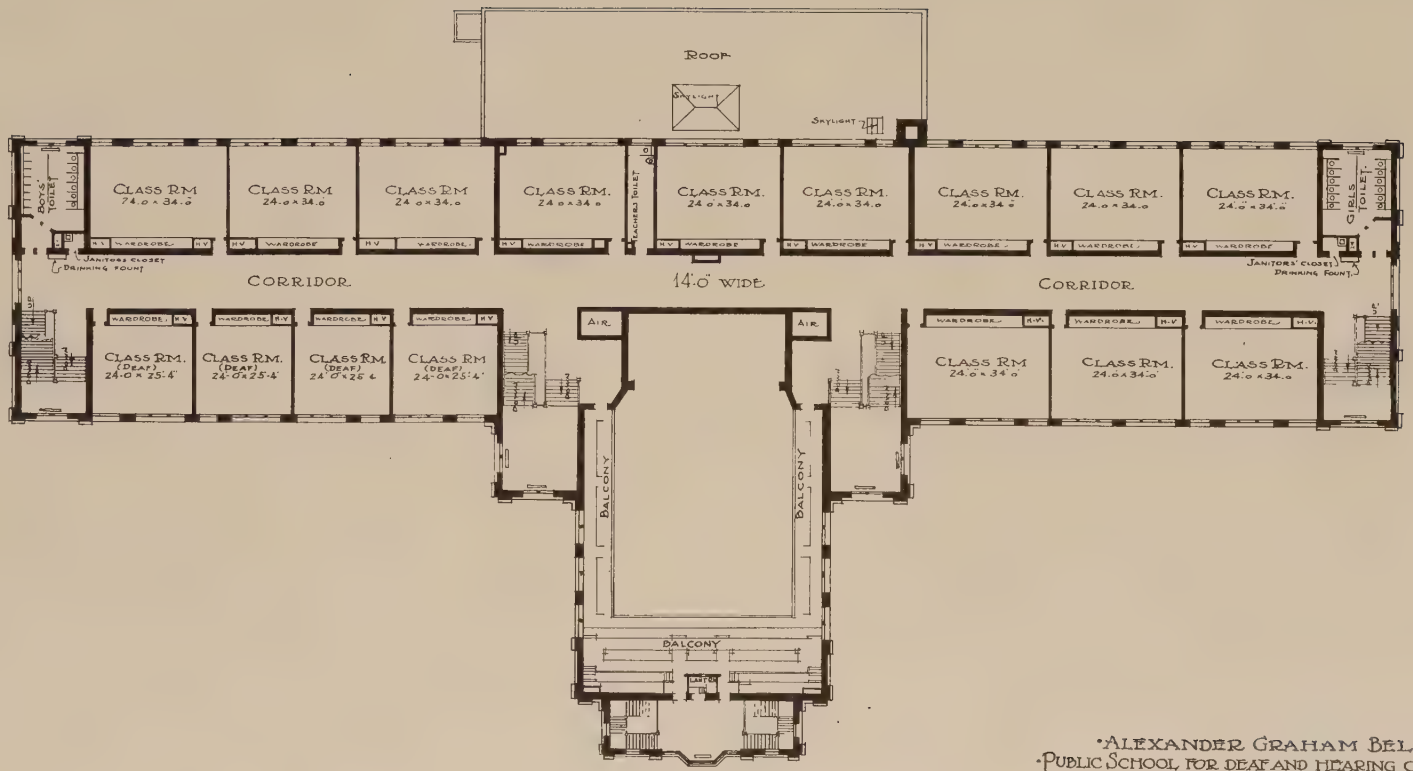


·FIRST FLOOR PLAN·
SCALE 1/16" = 1 FOOT.

·ALEXANDER GRAHAM BELL.·
·PUBLIC SCHOOL FOR DEAF AND HEARING CHILDREN·
TO BE BUILT UPON SITE AT
·GRACE ST. AND CLAREMONT AV.·
·A.F. HUSSANDER, ARCH'T, BOARD OF EDUCATION, CHICAGO.·

(1)

FIG. 33.

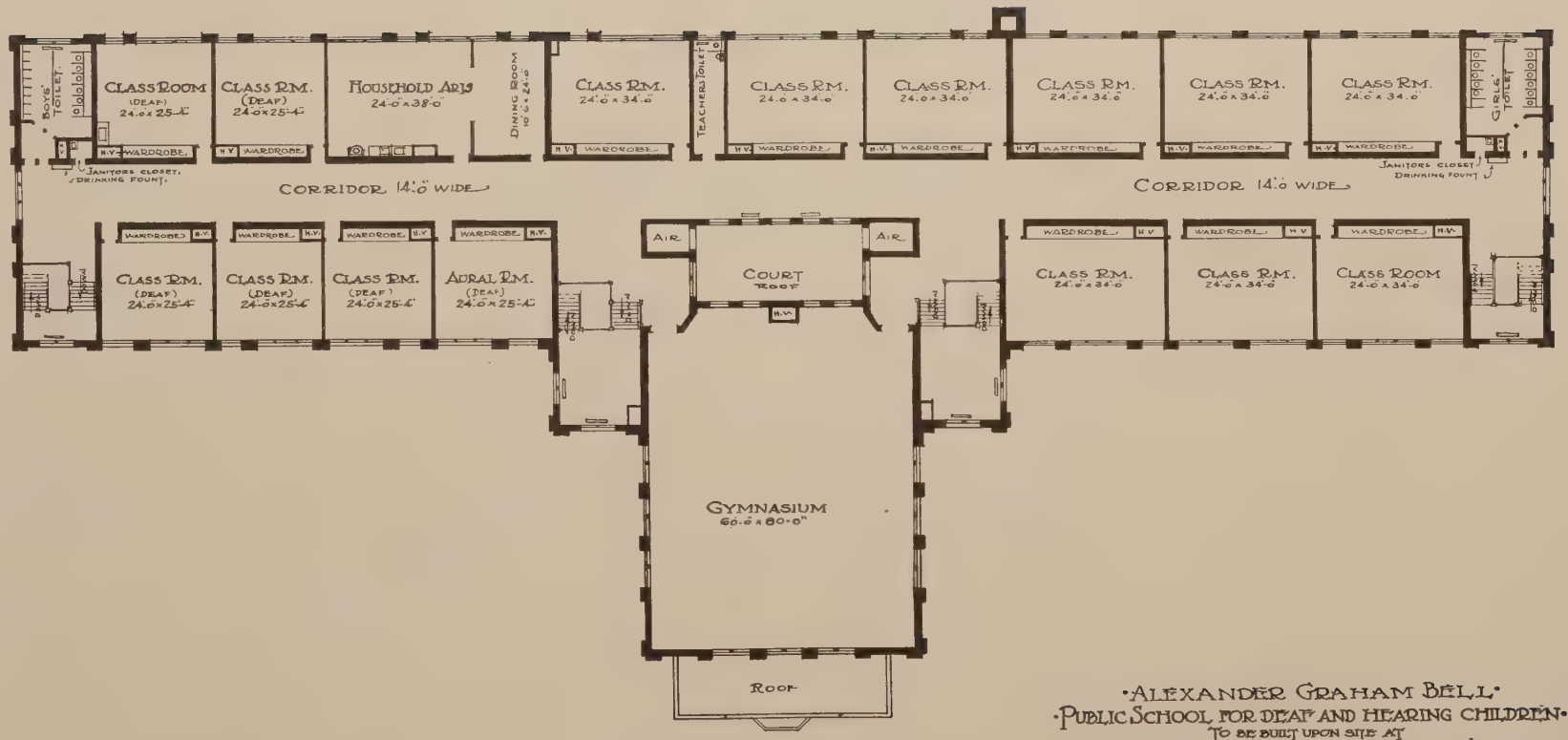


·SECOND FLOOR PLAN·
SCALE 1/16" = 1 FOOT.

·ALEXANDER GRAHAM BELL·
·PUBLIC SCHOOL FOR DEAF AND HEARING CHILDREN·
TO BE BUILT UPON SITE AT
GRACE ST AND CLAREMONT AV.
·A.F. HUSSANDER, ARCHT., BOARD OF EDUCATION, CHICAGO.·

(2)

FIG. 34.



THIRD FLOOR PLAN.
SCALE 1/16 - 1 FOOT.

ALEXANDER GRAHAM BELL.
PUBLIC SCHOOL FOR DEAF AND HEARING CHILDREN.
TO BE BUILT UPON SITE AT
GRACE ST. AND CLAREMONT AV.
A.F. HUSSANDER, ARCH'T. BOARD OF EDUCATION, CHICAGO.

FIG. 35.

Messrs. Perkins, Fellows and Hamilton, Architects.

FIG. 36. — NEW TRIER TOWNSHIP HIGH SCHOOL, KENILWORTH, ILLINOIS.

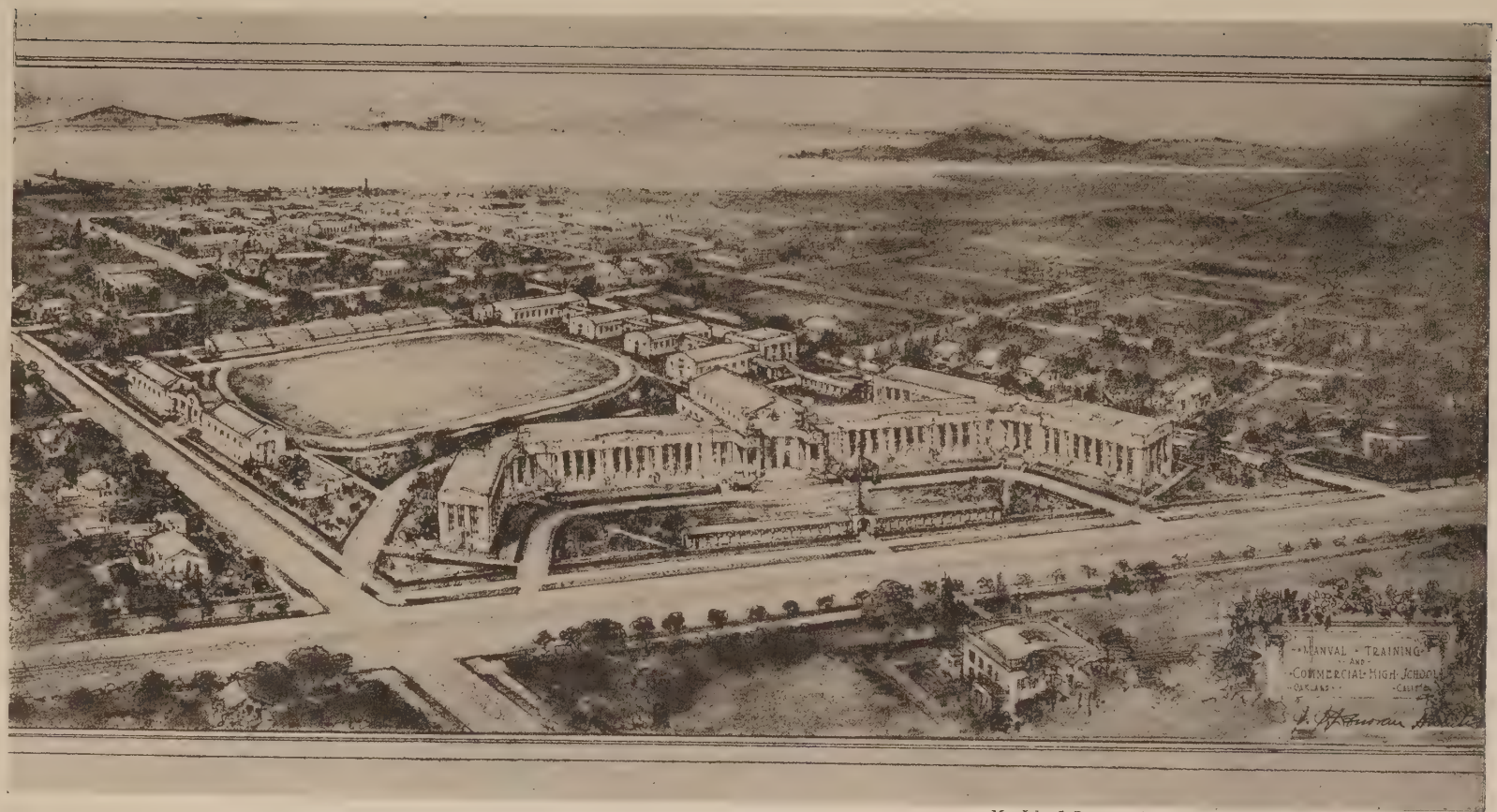
Allison and Allison, Architects.

FIG. 36 A. SANTA MONICA HIGH SCHOOL, ELLIOT MEMORIAL ENTRANCE GATE. FROM FREMONT AVENUE ON SOUTH SIDE OF GROUNDS, LOS ANGELES.

Mr. John J. Donovan, Architect. *Mr. Henry Hornbostel, Consulting Architect.*

Page 42

FIG. 37. — OAKLAND TECHNICAL HIGH SCHOOL, OAKLAND, CALIFORNIA.

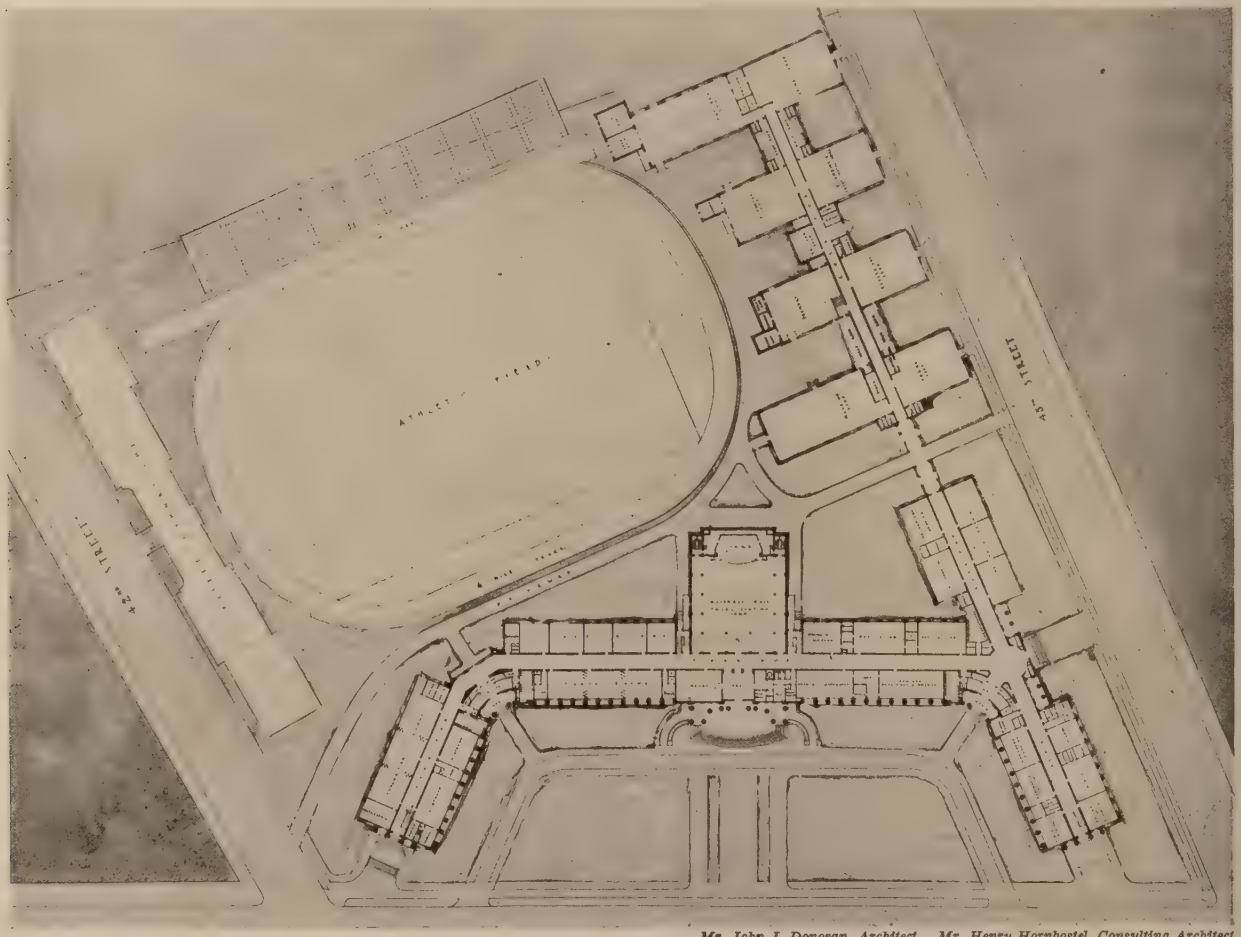


Mr. John J. Donovan, Architect. *Mr. Henry Hornbostel, Consulting Architect.*

FIG. 38. — PRELIMINARY PERSPECTIVE DRAWING — OAKLAND TECHNICAL HIGH SCHOOL, OAKLAND, CALIFORNIA.

Mr. John J. Donovan, Architect. Mr. Henry Hornbostel, Consulting Architect.

FIG. 39. — OAKLAND TECHNICAL HIGH SCHOOL, OAKLAND, CALIFORNIA.



Mr. John J. Donovan, Architect. Mr. Henry Hornbostel, Consulting Architect.

FIG. 40. — FIRST FLOOR PLAN — OAKLAND TECHNICAL HIGH SCHOOL, OAKLAND, CALIFORNIA.

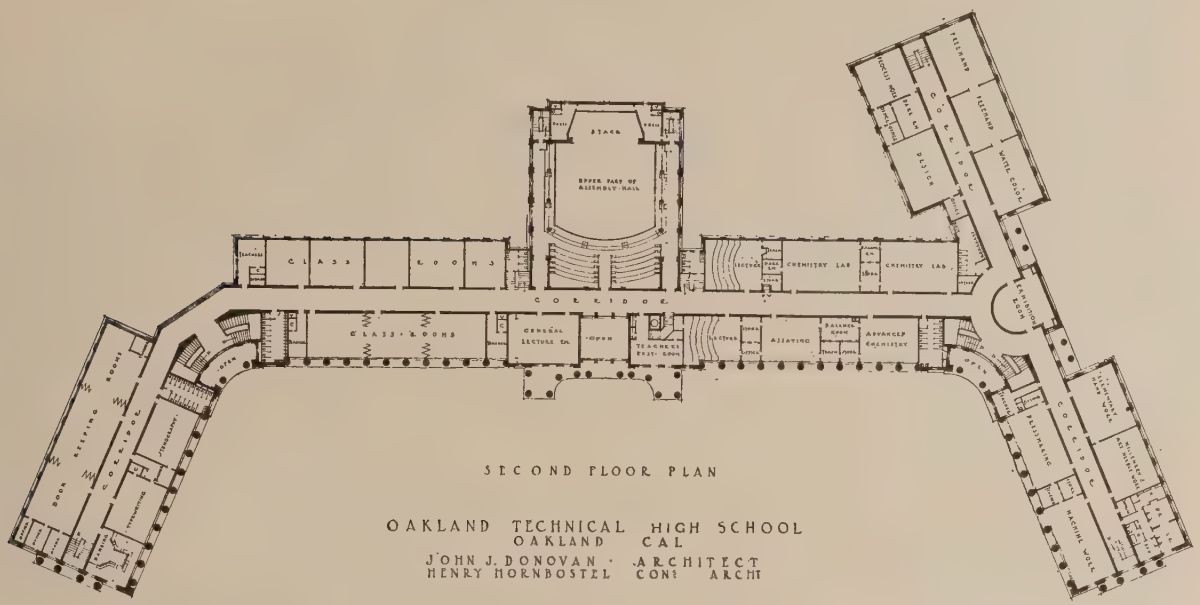


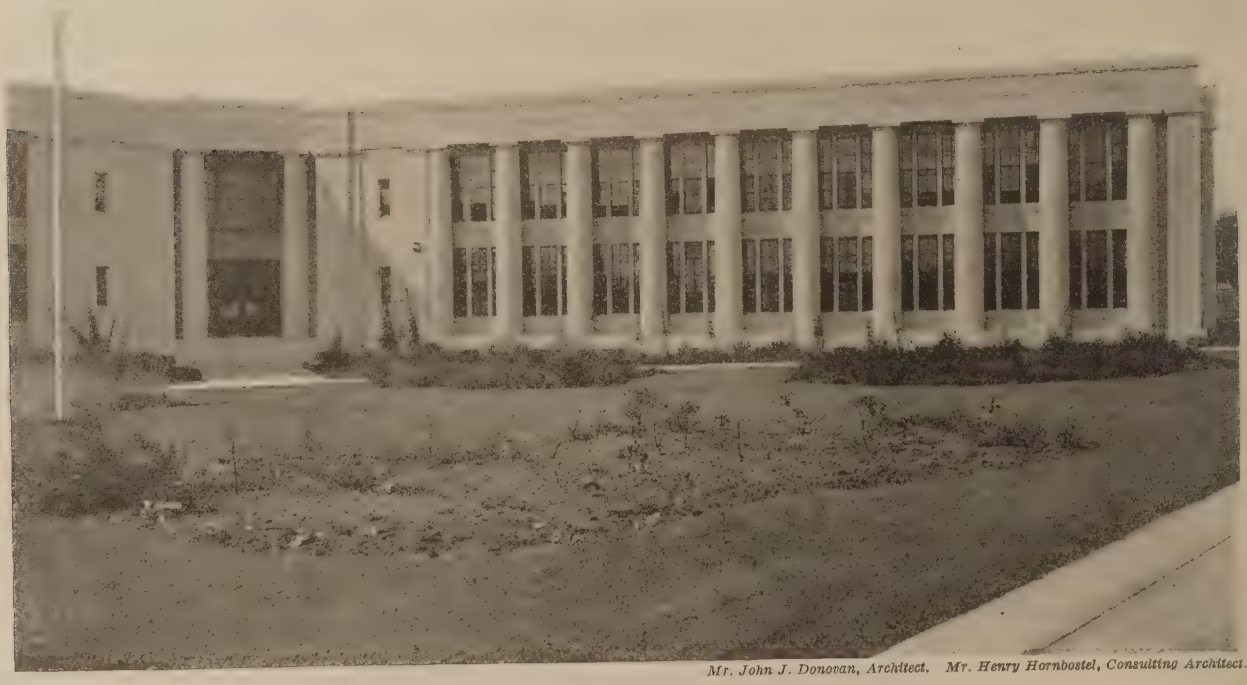
FIG. 41.

Mr. John J. Donovan, Architect. Mr. Henry Hornbostel, Consulting Architect.

FIG. 42. — OAKLAND TECHNICAL HIGH SCHOOL, OAKLAND, CALIFORNIA.

Mr. John J. Donovan, Architect. Mr. Henry Hornboste., Consulting Architect.

FIG. 43. — OAKLAND TECHNICAL HIGH SCHOOL, OAKLAND, CALIFORNIA.



Mr. John J. Donovan, Architect. Mr. Henry Hornbostel, Consulting Architect.

FIG. 44. — OAKLAND TECHNICAL HIGH SCHOOL, OAKLAND, CALIFORNIA.

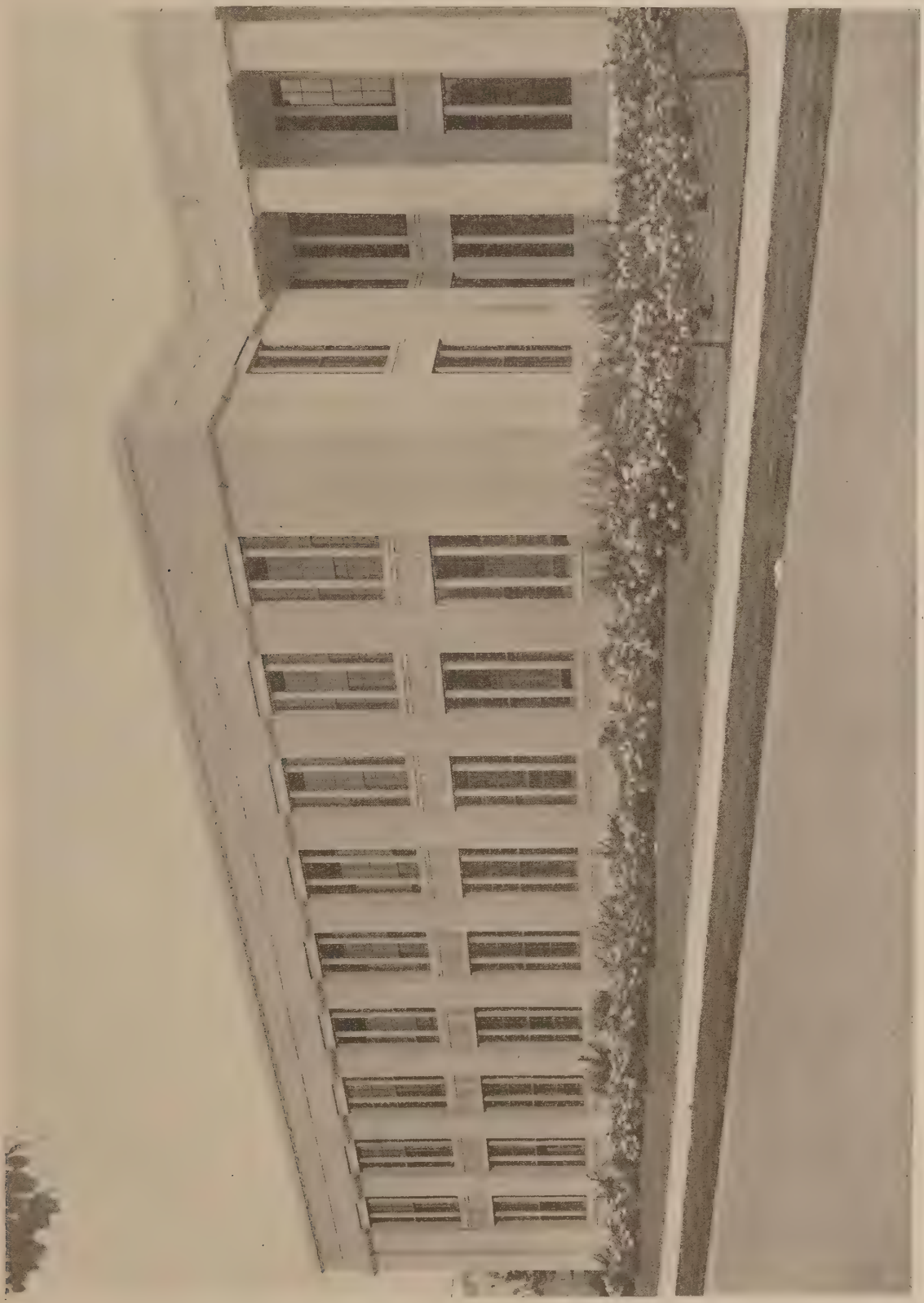


FIG. 45. — OAKLAND TECHNICAL HIGH SCHOOL, OAKLAND, CALIFORNIA.

Mr. John J. Donovan, Architect. Mr. Henry Hornbostel, Consulting Architect.

FIG. 46. — OAKLAND TECHNICAL HIGH SCHOOL, OAKLAND, CALIFORNIA.

Mr. John J. Donovan, Architect. Mr. Henry Hornbostel, Consulting Architect.

Mr. John J. Donovan, Architect. *Mr. Henry Hornbostel, Consulting Architect.*

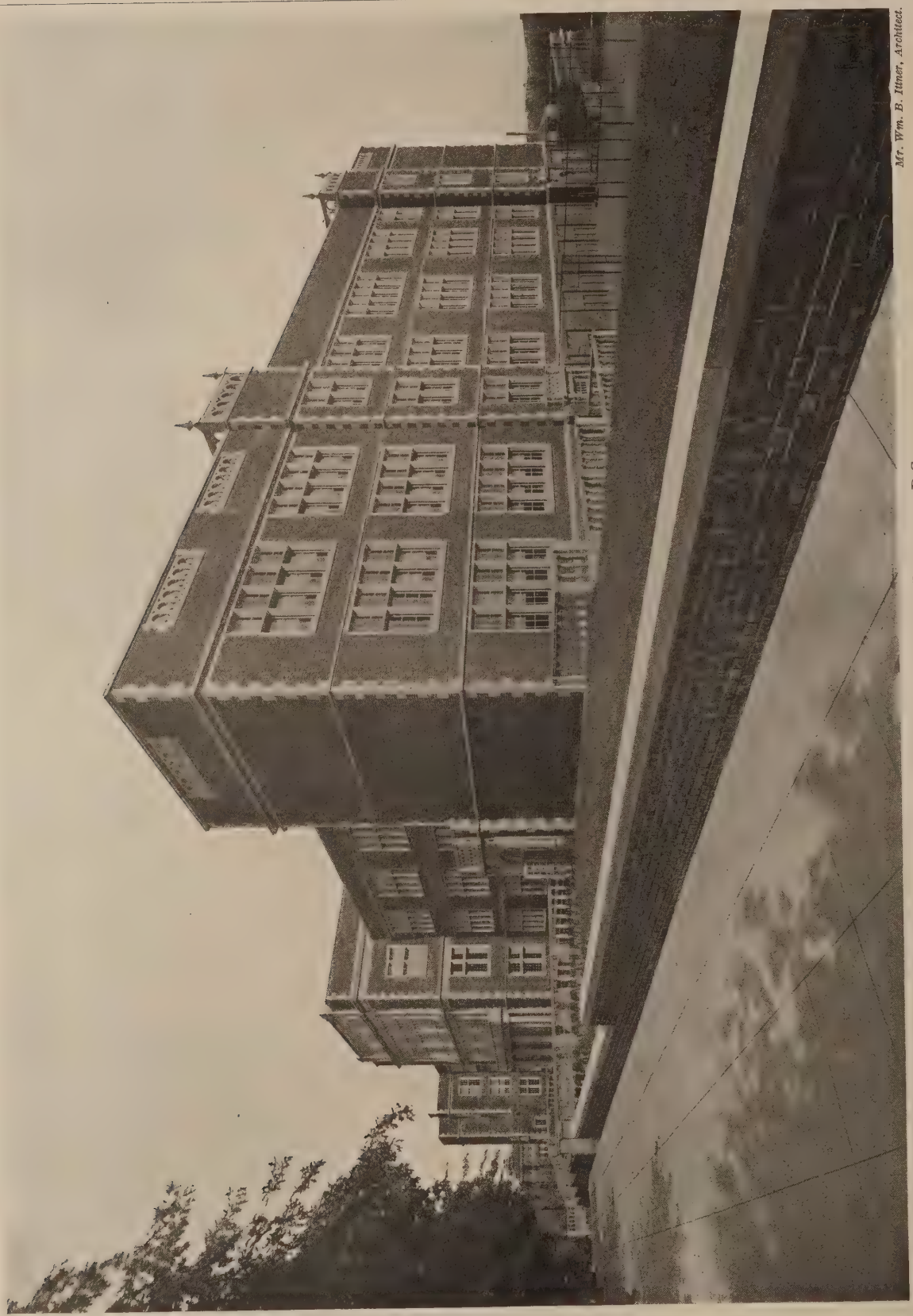
FIG. 47. — OAKLAND TECHNICAL HIGH SCHOOL, OAKLAND, CALIFORNIA.

Mr. Wm. B. Ittner, Architect.

FIG. 48. — CENTRAL HIGH SCHOOL, WASHINGTON, D.C.

Mr. Wm. B. Ittner, Architect.

FIG. 49. — CENTRAL HIGH SCHOOL, WASHINGTON, D.C.



Mr. Wm. B. Ittner, Architect.

FIG. 50. — CENTRAL HIGH SCHOOL, WASHINGTON, D.C.

Mr. Wm. B. Ittner, Architect.

FIG. 51. — CENTRAL HIGH SCHOOL, WASHINGTON, D.C.

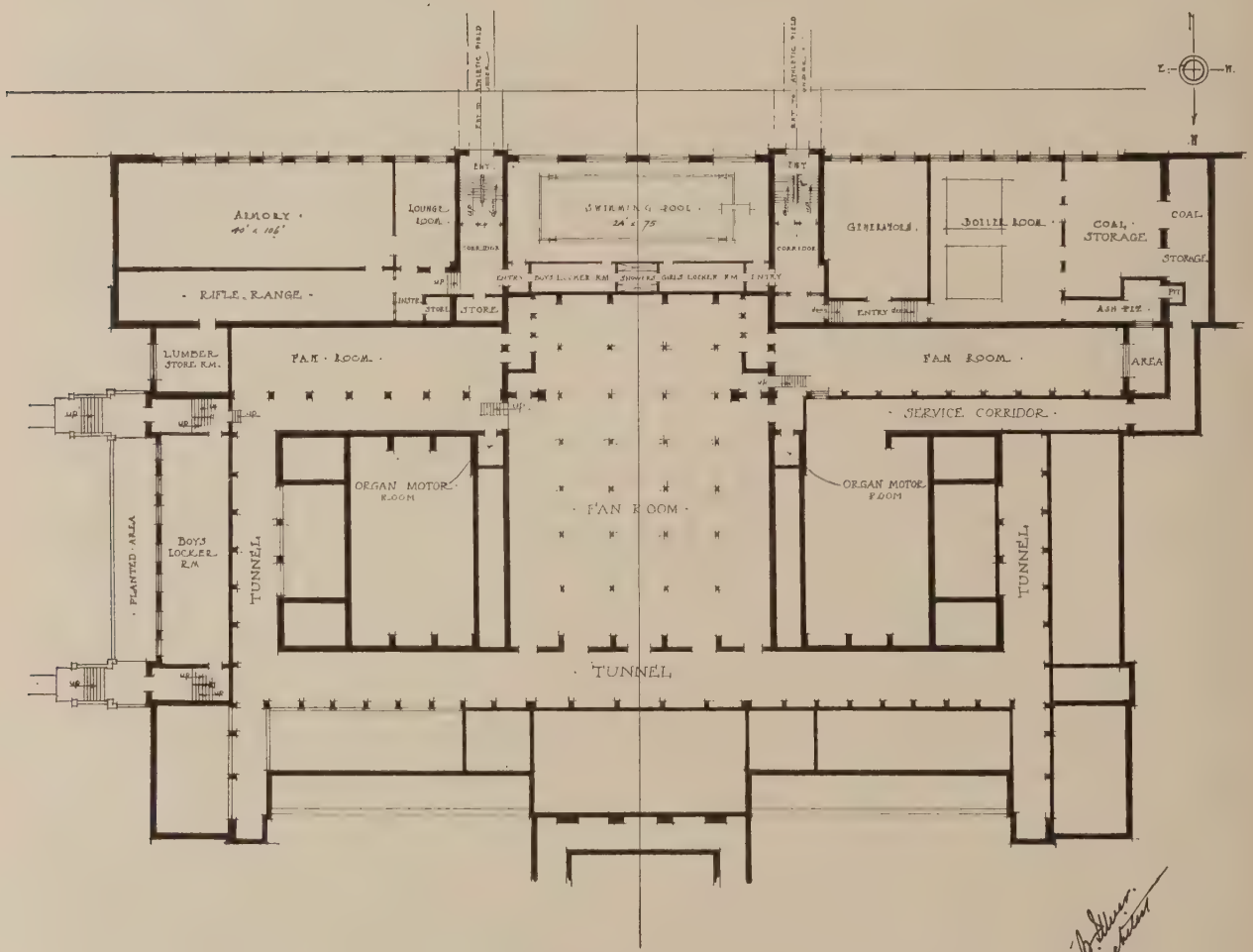
Mr. Wm. B. Ittner, Architect.

FIG. 52. — CENTRAL HIGH SCHOOL, WASHINGTON, D.C.

FIG. 53. — CENTRAL HIGH SCHOOL, WASHINGTON, D.C.

FIG. 54. — CENTRAL HIGH SCHOOL, WASHINGTON, D.C.

Mr. Wm. B. Ittner, Architect.



BASEMENT FLOOR PLAN

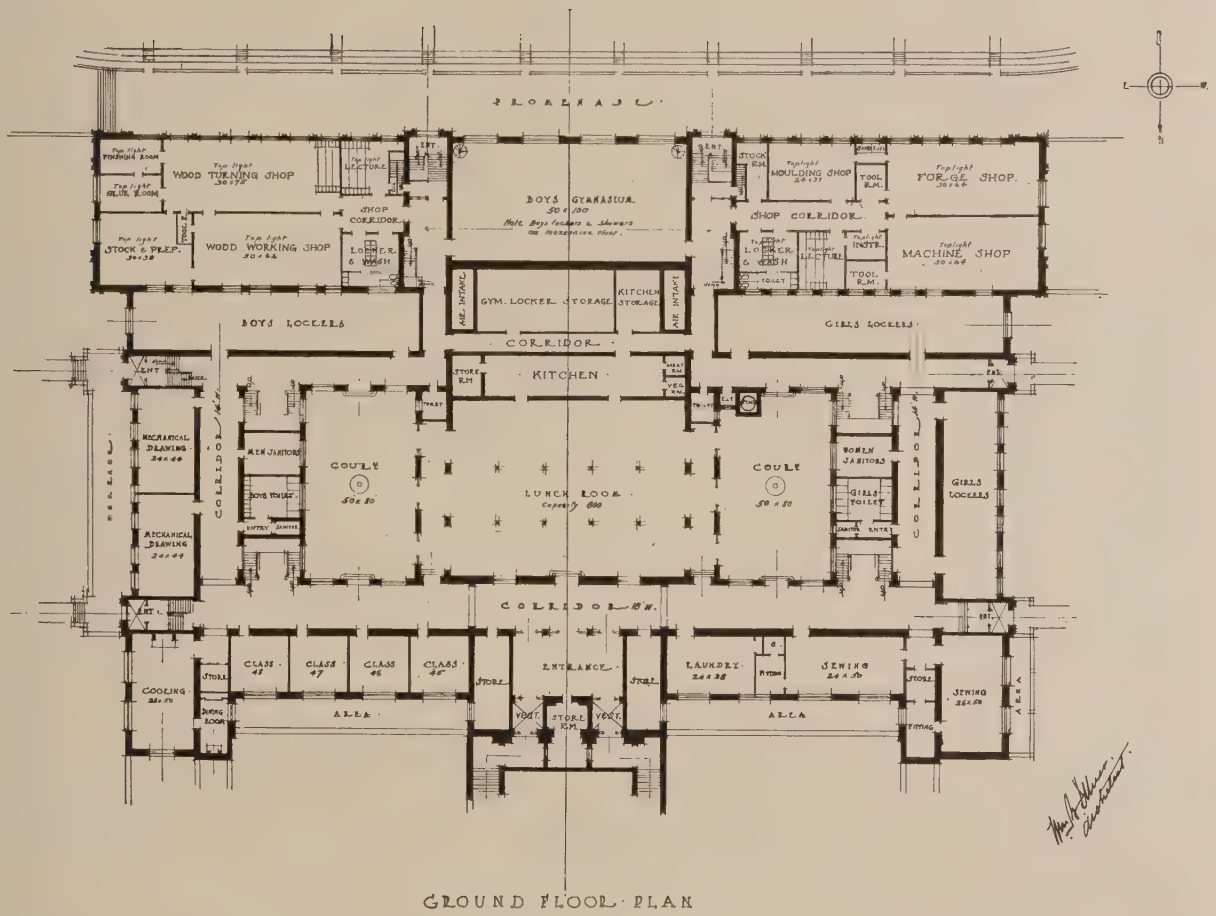
SCALE 1/32"=1'-0"

HIGH SCHOOL WASHINGTON D.C.

WM. B. ITTNER ARCHITECT - - ST. LOUIS

DEC 1912.

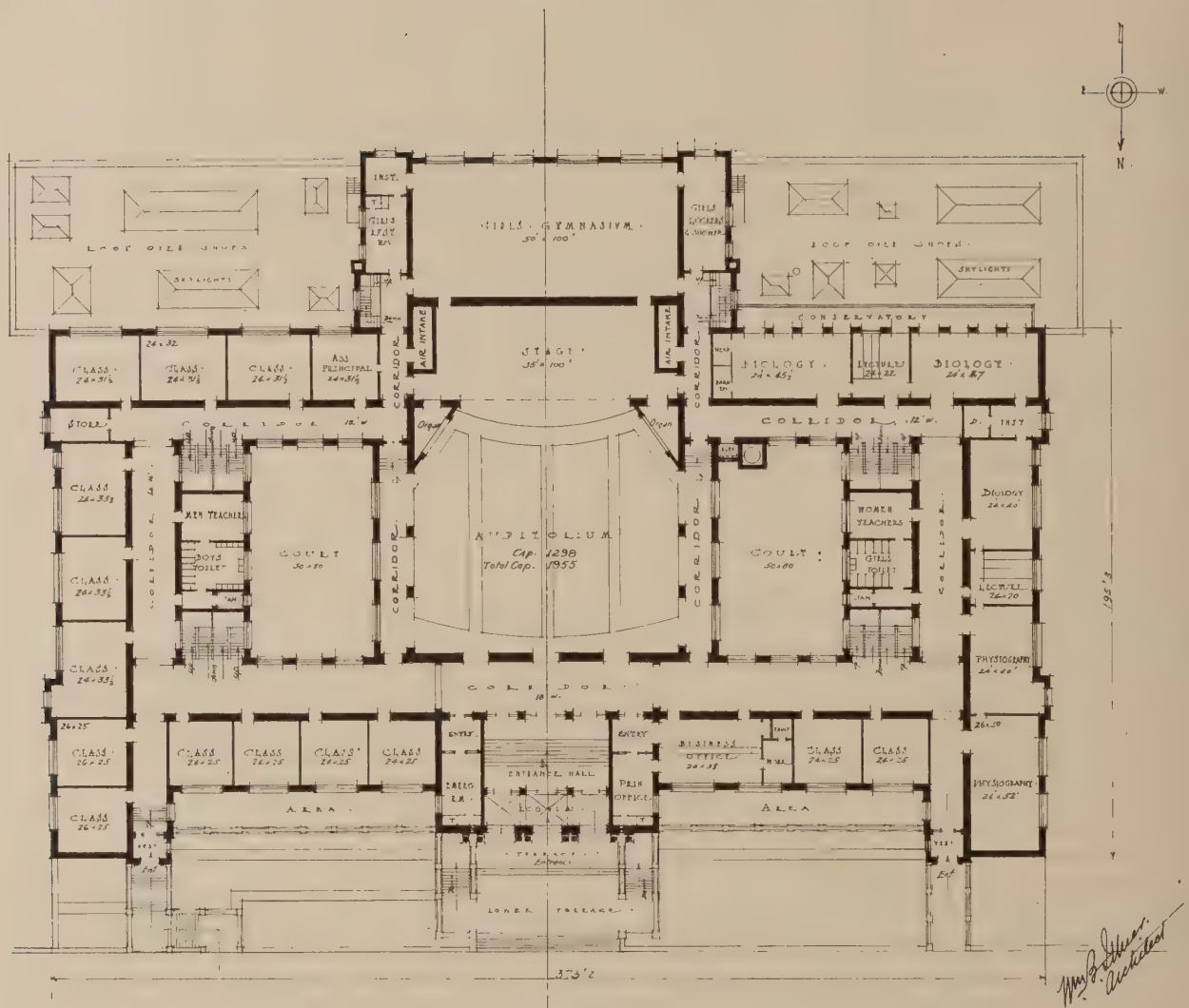
FIG. 55.



GROUND FLOOR PLAN

HIGH SCHOOL, WASHINGTON, D.C.
WM. B. ITTNER, ARCHITECT. ST. LOUIS
DEC. 1912.

FIG. 56.



FIRST · FLOOR · PLAN

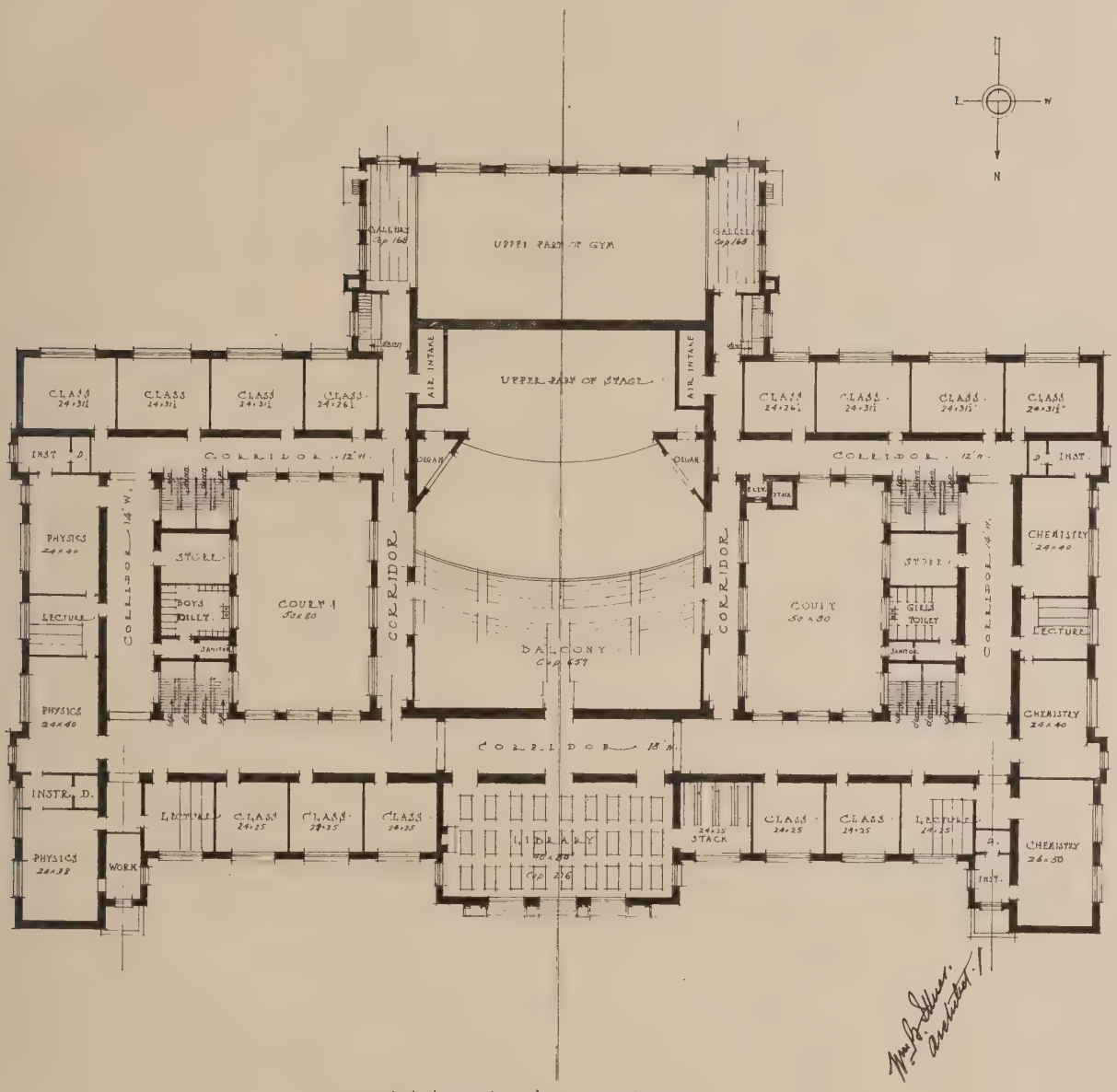
SCALE 1/8"-1'-0"

HIGH SCHOOL WASHINGTON D.C.

WM. B. ITTNER ARCHITECT · ST. LOUIS ·

DECEMBER 1912

FIG. 57.



SECOND FLOOR PLAN.

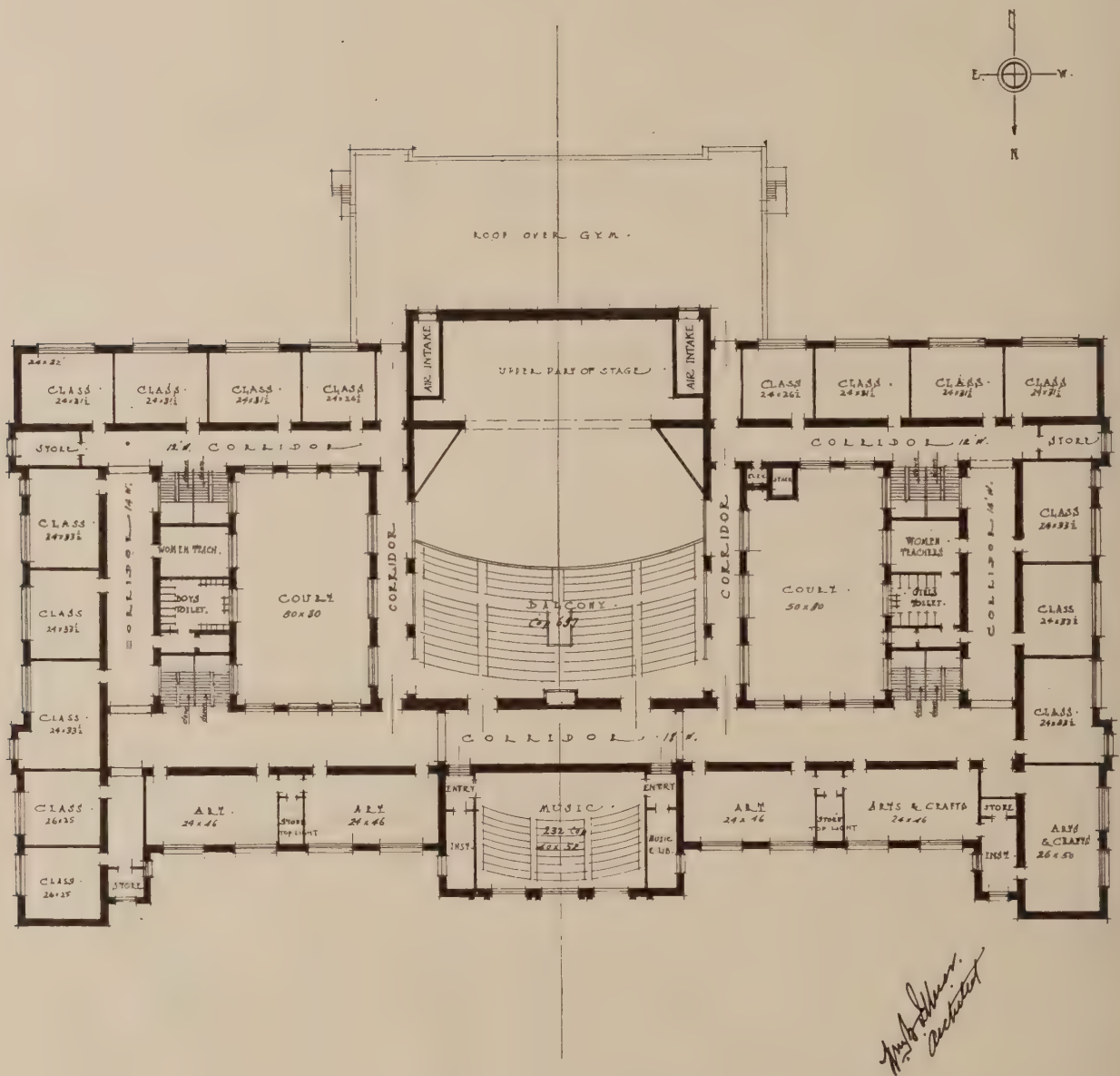
SCALE 1/32"=1'0"

HIGH SCHOOL, WASHINGTON D.C.

WM. B. ITTNER, ARCHITECT. ST. LOUIS

DEC. 1913.

FIG. 58.



THIRD FLOOR PLAN.

SCALE 1/32"-1'0"

HIGH SCHOOL, WASHINGTON, D.C.

WM. B. ITTNER, ARCHITECT, ST. LOUIS

DEC. 1912.

FIG. 59.

CHAPTER III

LANDSCAPE DEVELOPMENT OF SCHOOL GROUNDS

By Howard Gilkey, B.S., *Landscape Architect*

Beauty in School Grounds. The Out-of-doors Part of the School. The Relation of Architecture and Planting. The Harmony of Lines, Color, and Texture in Plant Composition. Indigenous Plants. The Use of Exotics. The Real Basis of Plant Selection. The Proper Use of Flowers. The Border Plantation. The Value of Landscape Architecture.

Beauty in School Grounds. — A man feels more the master of his fate when well clothed than in rags. It is equally true that a child will aspire to nobler aims in contact with beautiful surroundings. It is important then that the community should foster a love of beauty, as it makes for better citizenship. To merely solve the practical requirements of living does not give evidence of as high a state of civilization as to set about the solution in a beautiful way. The school as the training house of the people must take this truth into consideration. It is no longer satisfactory that the school and its grounds and buildings be adequate for instruction purposes; they should be beautiful as well. We must not tolerate conditions formerly prevailing when the school building reared itself on a dusty, treeless expanse of earth. For the child who comes from a home equally unattractive, such a place offers nothing that will satisfy the innate longing for the beautiful, — an instinct modern civilization must find the means to develop. With such development a long step in advance toward the eradication of unwholesome living conditions will have been made.

The Out-of-doors Part of the School. — It is no longer believed that the school is confined to the four walls of the building. Certain activities of the child are housed within walls; others are "housed" out-of-doors. The architecture of the school building, through daily inspiration, develops good taste in the child. Pictures on the wall, copies of the Masters, stimulate æsthetic appreciation. Similarly the pupils become familiar with the best in every sphere of human thought and endeavor. In the modern school this application of good principle does not confine itself to the building; it is continued into the school grounds, where it endeavors to provide the best environment for the activities that are to take place outside the building itself. Open-air activities are both recreational and vocational. They increase in number and complexity with the growth of the child, requiring more and more space and involving greater expense. To provide an economical arrangement of the areas required by these activities, the unity and order of which becomes a source of beauty to be enhanced by judicious planting, is the function of good design applied to school grounds.

Grounds surrounding school buildings have been too small, with every available inch of space used for play. There has not been room for the planting of trees and grass. It should not be inferred that any part of the child's enjoyment is to be sacrificed for the mere sake of making playgrounds attractive. Playgrounds are primarily for children, and secondarily for the growth of plants. But as the physical development of the child requires conditions hygienically correct, in like manner his unfolding mind needs an environment of order and beauty. To provide this, more land must be secured, as the play-space should not be restricted.

Play and planting will not mix. Hence the first important thing in the general plan is to separate the grounds into their several space units. These will consist roughly of areas where (1) play is the controlling element, where (2) planting for æsthetic purposes is the leading factor, and where (3) the ground is devoted to school gardens whose function is purely educational. It is with the second of these that our discussion will be largely concerned.

The Relation of Architecture and Planting. — The choice adjustment of architectural and horticultural elements produces a composition most nearly approaching absolute beauty. "From the intimate union of art and nature, of architecture and the landscape, will be born the best gardening compositions, which time, purifying public taste, now promises to us."[1] It is in his treatment of the main façade of the

[1] Édouard André.

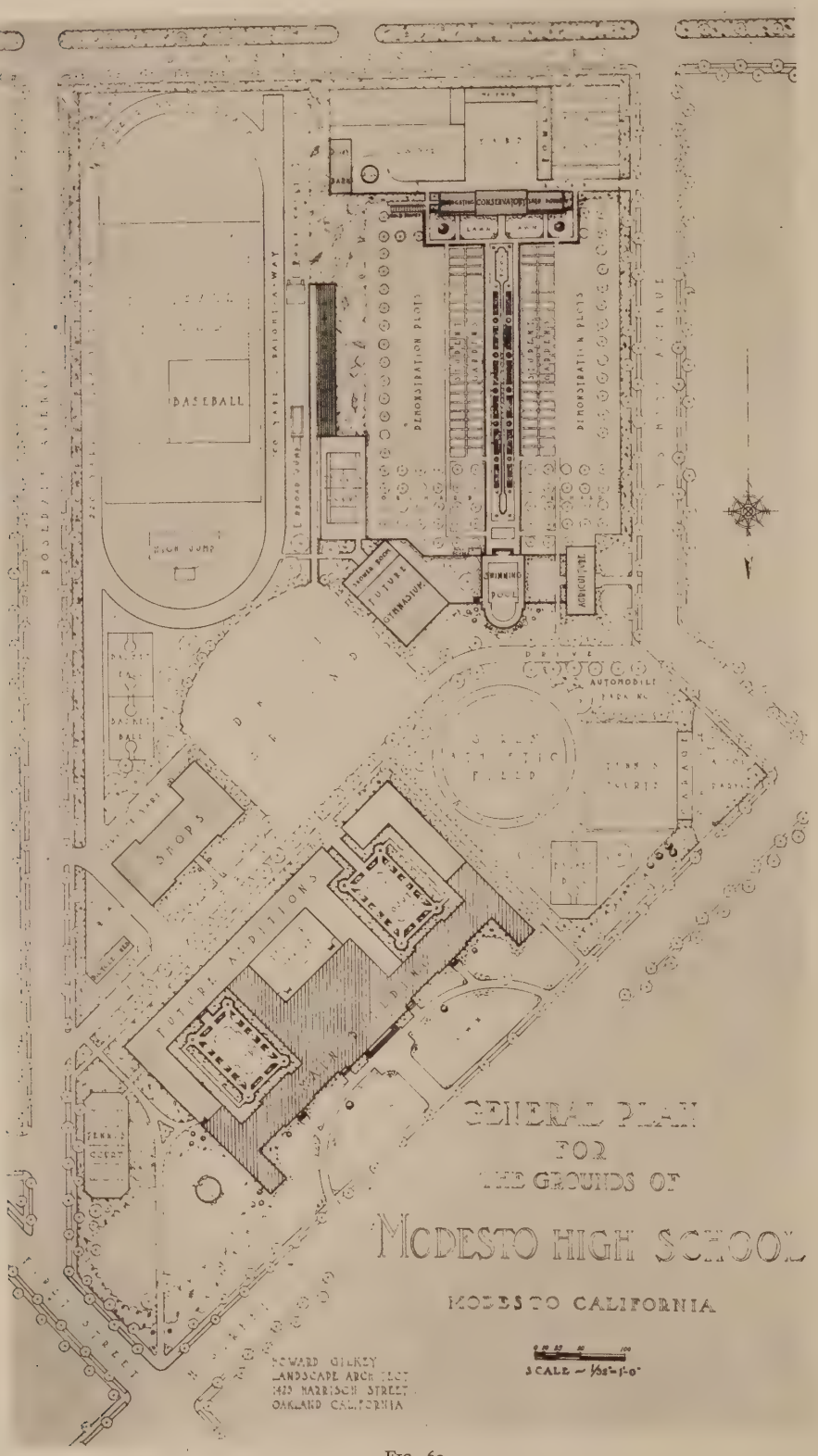

BASEBALL
HIGH JUMP
DEMONSTRATION PLOTS
DEMONSTRATION PLOTS
SWIMMING POOL
FUTURE GYMNASIUM
AUTOMOBILE PARK
STOPS
FUTURE ADDITIONS
GENERAL PLAN
FOR
THE GROUNDS OF
MODESTO HIGH SCHOOL
MODESTO CALIFORNIA
SCALE — 1/32"-1'-0"
HOWARD GILKEY
LANDSCAPE ARCHITECT
1423 HARRISON STREET
OAKLAND CALIFORNIA

FIG. 60.

building that the architect has the opportunity to give expression to the æsthetic ideals born of his profession. But this is only part of the complete composition; it is fitting that the charm of the structure should be enhanced by complementary planting. The building and the grounds form a complementary relationship in the larger unity. Architecture is rigid; planting is yielding. Architecture furnishes the high light and the deep shadow, while planting supplies the half tones. The austere quality of the building art requires the added softness of foliage.

It is in this complementary part that the artistic sympathy for values created by the architect should be considered by the landscape designer. It is not merely a matter of planting shrubbery about a building in order to cover bare spaces of soil. Even worse than the unfortunately common practice of placing a well-designed work of architecture in the center of a bare lot, is the injudicious development of an overplanted and unsympathetically studied scheme. The appearance of an imposing building can be completely ruined by plantations, indiscriminately placed about the structure. On the other hand, no amount of carefully studied tree grouping can give charm to an inherently ugly building. It is best to efface it. One of the greatest delights that comes to a landscape architect is the creation of a composition dominated by a masterly work of architecture.

The public has gradually awakened to the necessity of good architecture for school buildings. Progressively, then, we may expect an increased interest in the landscape development of the grounds about these buildings, for, as Lord Bacon said, " A man shall ever see that when ages grow to civility and elegancy, men come to build stately sooner than to garden finely, as if gardening were the greater perfection."

Perhaps there is no greater opportunity of producing that " pleasing contrast in the juxtaposition of art and nature " than in the treatment of the front approach of a school. The modern school building particularly lends itself to the graces of the landscape. Necessity demands that simplicity prevail and that small expense be lavished upon details of finishing except on principal entrances where money can be well spent. Often broad expanses of bare walls, including the ends of whole wings, are necessary to secure the requisite unilateral lighting for the classrooms, and often the base of the building is left unrelieved by moldings. All these conditions permit of planting close to the walls; in fact, they require it. The architectural errors then cease to be an obtrusion thrust into the heart of nature, but are tied to nature by transitional lines.

The Harmony of Lines, Color, and Texture in Plant Composition. — The accomplishment of that transition becomes the chief rôle of the landscape architect. A graphic illustration of the principle is that of a right angle with a curved bracket joining the two legs. At its ends the curve conforms more and more to the respective straight lines which it connects. In much the same manner the lines of the shrubbery should merge into the lines of the architecture. At a distance remote from the structure, the planting should be, as near as we can comprehend it, that of nature, soft, undulating, harmonious. As it approaches the building it becomes more servile to the lines, masses, and color of the architecture. In this way, contrasting vertical lines are with greater frequency introduced, breaking the undulating silhouette of shrubbery.

Besides the prominent verticalities which break the skyline already referred to, fully as important are the phases of color and texture composition. A bold mass of color misplaced draws the attention powerfully from the true center of interest, which should be some feature of the building. Properly placed, the same mass of color may tend to fix the attention upon the main objective.

Often it happens that the finished building does not fully satisfy the color sense of the architect. This is particularly true with brick buildings, where the final effect varies from a state of harshness to one of lifelessness. By the introduction in the first case of foliage color tending to harmonize with the brick color, and in the second case of foliage color tending to be complementary to the brick color, the general tone may be softened or heightened as desired. A building of rich color, whether of brick, terra cotta, sgraffito, or of colored plaster, will require much restraint of foliage color, while a simple gray plastered surface may be the canvas upon which to display a vast amount of color in vines, trees, and shrubs. A simple structure of no particular individuality may well be smothered in soft masses of vegetation and color. It will be readily seen that the use of color about a structure of considerable dignity is a matter of no small consideration.

Harmony of texture is most easily obtained but seldom seen. Simply stated, plants of harmonious texture have leaves of the same general shape and size. The landscape designer is able to select many unrelated plants and secure a simple harmony by planting together those which have a uniform texture, progressing in a sequential manner to other forms of coarser or finer quality. The tasteful introduction of contrasts follows the same general procedure. In this way an occasional bold spot of foliage may be relieved against the background of a finer-textured mass, thus introducing more spirit into the planting design as the dominating architectural motive is approached. A stronger composition will by this means be produced.

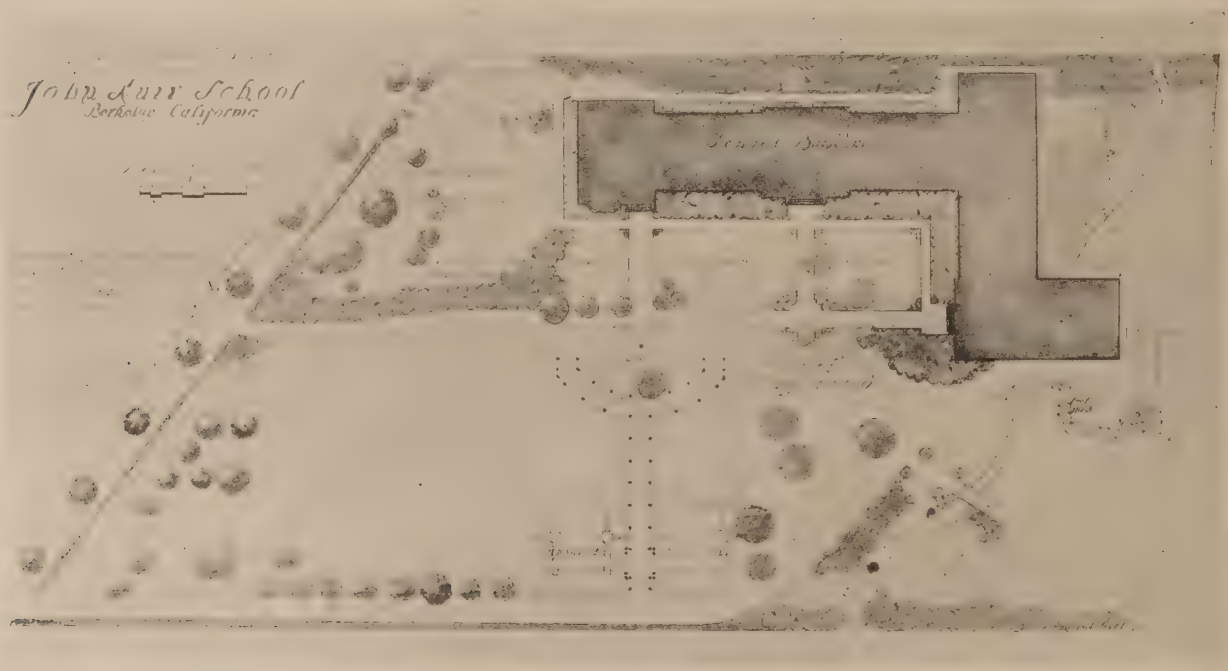


Fig. 61.

When this arrangement is accomplished it will be apparent that to secure the finest effect there should be ample opportunity provided for viewing the entire façade in a comprehensive manner. This is a justifiable reason for setting the building back as much as a hundred feet from the street. But in addition to this is the necessity for quiet and seclusion for the classroom, in a location remote from the noises of the street. Hand in hand are the practical and æsthetic requirements; and solving one is to make the solution of the other possible.

After securing a pleasing composition of building lines and base planting, the effect should not be lessened by introducing distracting foreground detail. From the street to the base plantation there ought to be a simple stretch of grass, except where necessary walks must be introduced. The serenity of the lawn should not be disturbed by scattering over its surface irregular groups, specimen trees, and those delights of the gardener, carpet beds in vulgar patterns. Occasionally a few trees will be required for shade, but it is better to forego this pleasing feature than to overplant. Above all, the gardener should not be permitted to indulge in ring-a-round-a-rosy beds, encircling every tree in the lawn. After the first few years the grass can grow as in nature, right up to the trunk of the tree. Shrubs may be grown on the lawn, but not scattered over its surface. Utility is the main consideration. Shrubs should be planted to prevent cutting corners, and at the same time to soften the junction of conflicting path lines. Little of this sort of planting will need to be done if the system of walks has been carefully studied.

Few flowers should be introduced in front of the building. It is not that they invite vandalism, for if they do, something is fundamentally wrong with the community, a condition which should be rectified if possible. The plants commonly called flowers, *i.e.*, the annuals requiring yearly renewal by sowing fresh seed, and the perennials whose tops die down but whose roots persist from year to year, are frequently moved, an operation which often results in discordant clashes of color, and which may provide false accents, nullifying the preconceived climax of effect. Since color is the most noticeable quality of plant growth, its scheme should be carefully studied and executed in permanent shrubs rather than in perishable flowers. There are many varieties of shrubs which are rich in color of flower, fruit, leaf, and even of twig.

The plant materials to be used in the landscape gardening of the school grounds should be mainly trees, shrubs, and vines. After becoming once established they require little care, a fact which makes the upkeep more certain of success. Often the janitor without previous experience has to add the gardening to his already long list of accomplishments. Therefore we should use materials which will require the least amount of attention. It is a fact that without adequate maintenance the best-laid plans will result in nothing worth while. It should be the purpose of good planting design to place the least burden upon future caretakers, thus insuring the success of the scheme.

Indigenous Plants. — Much disappointment will be avoided by using native material. This alone is a

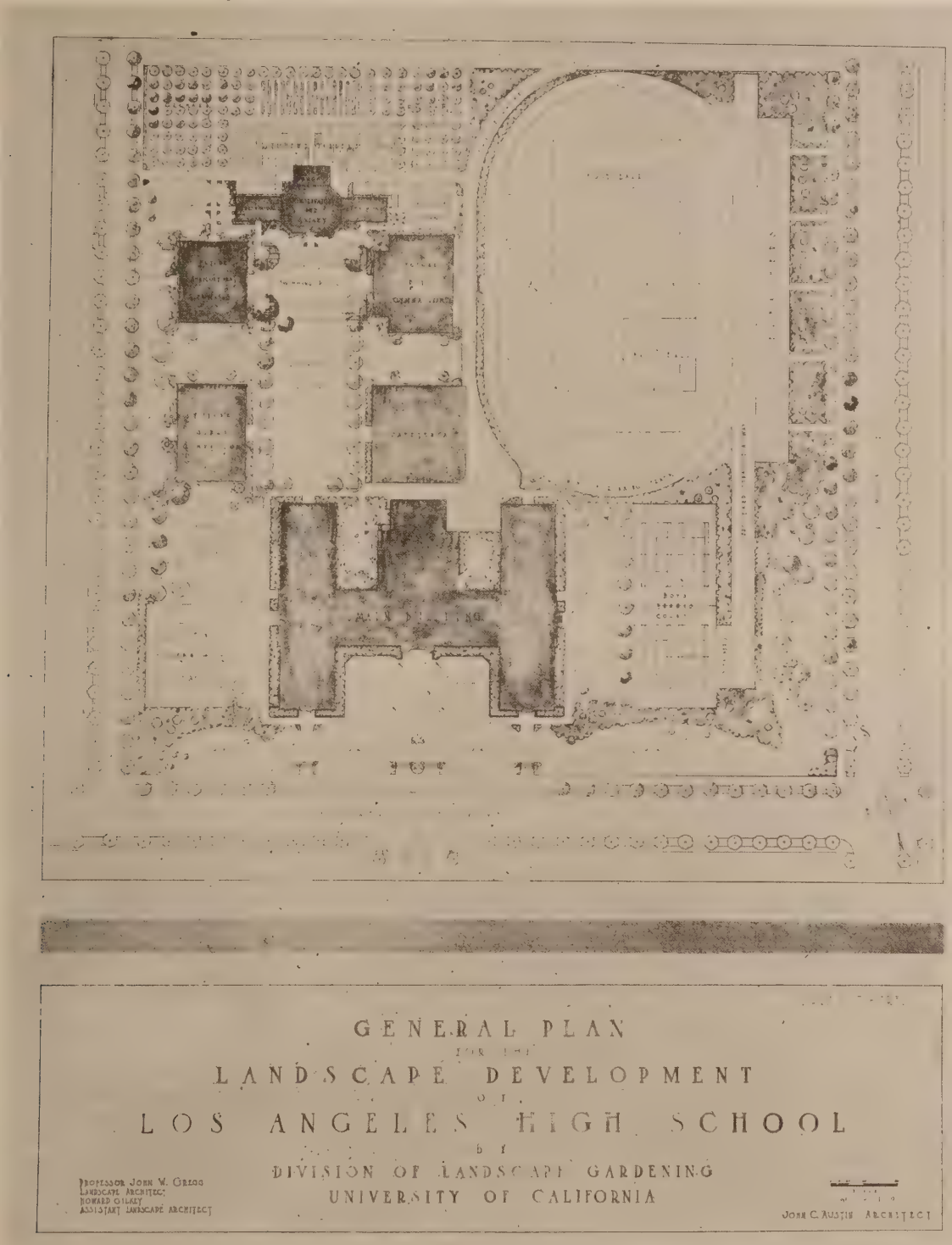

GENERAL PLAN
FOR THE
LANDSCAPE DEVELOPMENT
OF
LOS ANGELES HIGH SCHOOL
BY
DIVISION OF LANDSCAPE GARDENING
UNIVERSITY OF CALIFORNIA
PROFESSOR JOHN W. GREGG
LANDSCAPE ARCHITECT
HOWARD GILLETT
ASSISTANT LANDSCAPE ARCHITECT
JOHN C. AUSTIN ARCHITECT

FIG. 62.

sufficient reason for the insistence upon the choice of indigenous plants. "What is fair, must be fit," applies here, for the wild things growing in the neighborhood are ready for all the whims of weather. They will be harmonious as well. It seems within the limits of generalization, that a given locality tends to produce vegetable forms which are harmonious, their harmony probably resulting from mutually similar processes of adaptation to meet the common environment. Not only should native plants be used because they are harmonious and fit, but they should be fostered from motives of local pride. Every child should know the principal trees, shrubs, vines, and flowers of the locality. Acquaintance with them can best be obtained through daily association. In a California school-ground we should expect to find the redwood, the giant Sequoia, the oak, the madrone, the incense cedar, the silver fir, the bay tree, the various pines, the big-leaf maple, the Christmas berry, the wild lilac, the carpenteria, the wild cherry, and wild coffee. In the Northwest, in addition to the members of the pine family already mentioned, we would look for many splendid conifers, such as the Lawson cypress and Douglas fir, with a profusion of rhododendrons, azaleas, huckleberry, and salal.

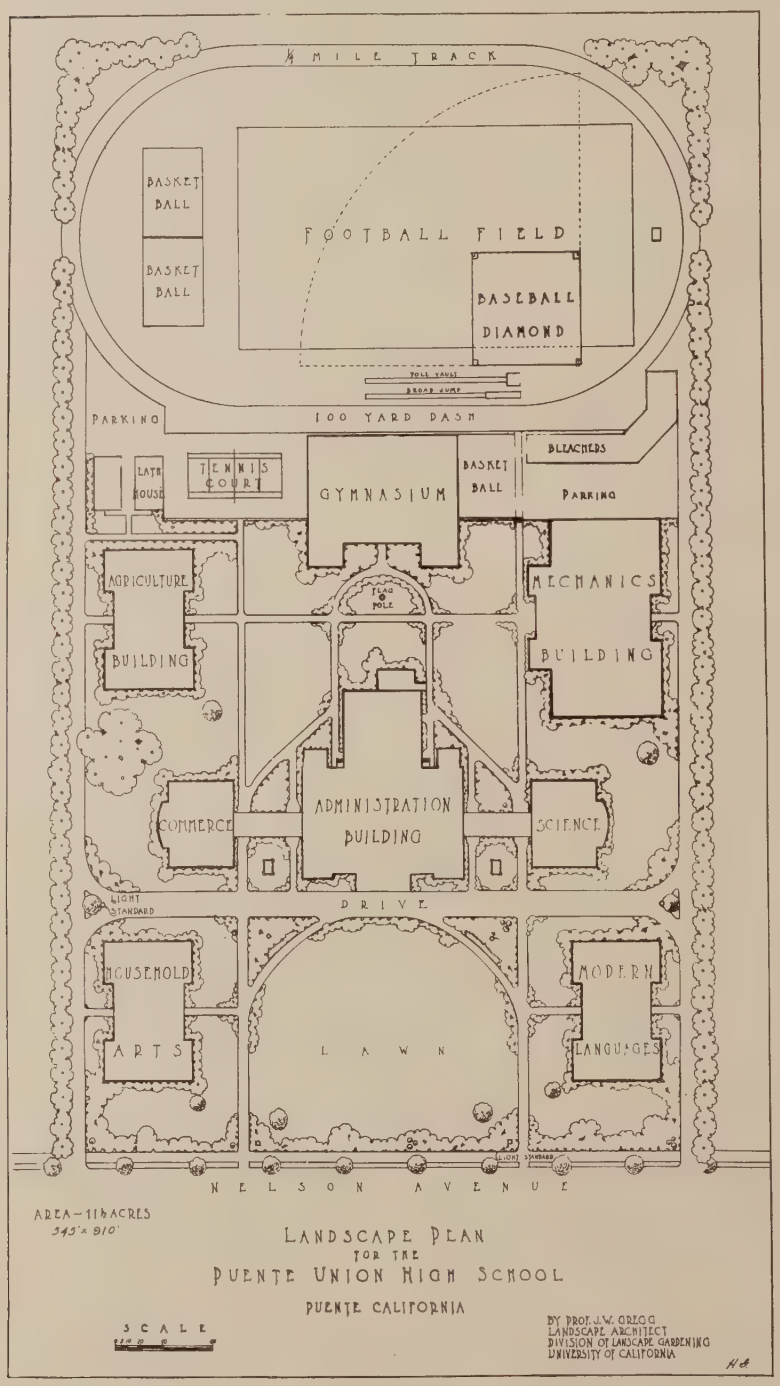


FIG. 63.

While native trees and shrubs should form an important part of the plant material for school landscape work, any outside materials which associate well should be used. Indeed, the landscape designer would be seriously handicapped if he were forced to use the limited number of forms found in some places. Plants partake obviously of the artificiality of their new positions, and often the wild straggling habit of much native growth will not be desired. Then, too, there is educational value in a greater assortment. Without becoming a veritable botanical garden, the school plantations should be varied for the simple purpose of providing material for instruction.

The Use of Exotics. — After a certain priority right has been given to the native plants, many from remoter regions whose climatic conditions are similar should be used, insuring hardihood and a certain degree of harmony. As an instance of this, it may be stated that in the interior valleys of California, where the summers are hot and dry, the winters wet, and very heavy frosts common, one finds, beside native plants, many species from southern Europe, North Africa, Asia Minor, Interior China, Northern Japan, and Southern Australia.

The Real Basis of Plant Selection. — Whatever the choice of plants, then let them be selected for their adaptation to the soil and the climate, their ability to stand rough usage and neglect, their appearance

of being at home in their appointed positions and affording a degree of variety for educational interest consonant with harmony of color and texture.

The numerous changes in plant life render the problem of design intricate. Every day of the year some new blossom is out; some new leaf unfolds; some mature one turns color, finally dropping off and exposing new lines of bare branches; some new cluster of berries grows warmer in tone and at length blazes into full richness of hue. The solution is not alone that of producing new interests throughout the year, but that of providing a tasteful arrangement of a series of compositions of texture and color, each merging insensibly into the next. At successive periods it will be apple blossom time, lilac time, the season for wild roses, clematis, plumbago, autumn leaves, and then berry season. At

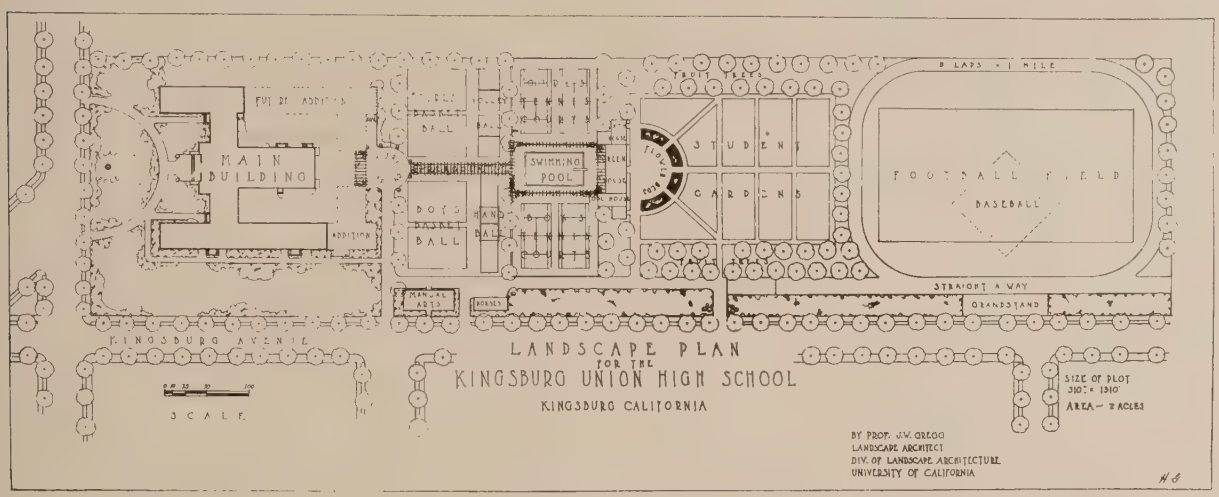


FIG. 64.

these periods there should be bold masses of the dominant color with lesser touches of more or less complementary hues to set them off. When soft pastel shades are used, the result may chance to be pleasing whatever the mixture. Certainly the inconsistencies will not be so glaring. It is in the use of the bright reds and yellows where taste and experience are necessary. Avoid magenta, a color which seems to clash with the usual hues of the landscape.

Of the seasons of the year, spring and summer will in variety of blossom take care of themselves; it is the fall and winter season that must have their share of enlivenment. Where autumn leaves are a conspicuous native charm, their brilliant hues can be made to tell as accents against more neutral backgrounds. A single poplar or a small group will gleam in soft yellow against a background of dull green pines. After the leaves have fallen, the same poplar will exhibit a graceful tracery of branches, adding the quality of etched lines, which may be just the touch needed to relieve a scene made heavy by monotonous masses.

The study of deciduous trees and shrubs and their composition value is too often slighted. The material at our command embraces the beech, the wild buckeye, the red-twigged dogwood, the yellow-barked willows, the sycamore, and the lovely white birch.

For the charm of pure rich color the berries supply the one element at the landscape architect's command comparable to the painter's primary palette. For many months they "stay put" in solid masses, at a time of year when the school is most active and the sky is dullest overhead. Californians may plant Christmas berry (the native toyon), pyracanthas, cotoneasters, mountain ashes, hawthorns, many of which are hardy in the East, where one must piece out with high-bush cranberry, holly, and rose hips. But wherever one finds them they are most gorgeous and most welcome. On the other hand the planting of berried shrubs can be very much overdone. The groups should not be too large and should not be placed without a greater mass of neutral foliage or a dull wall as a background. The masses must be well-shaped and not mere blots of loud color. In front of a symmetrical building they should be arranged with the idea of balance continuously in mind.

Proper Use of Flowers. — Little has been said about flowers. Aside from the restricted use of a clump of irises here and there, pentstemons, foxgloves, or a clump of hollyhocks in a corner, the place for the flowers is in the students' gardens. Roses may be introduced, forming part of the shrub masses, varieties with good foliage, such as the Irish Elegance, Cherokee, and Madame Cecille Brunner. Most roses, however, require too much pruning, spraying, and

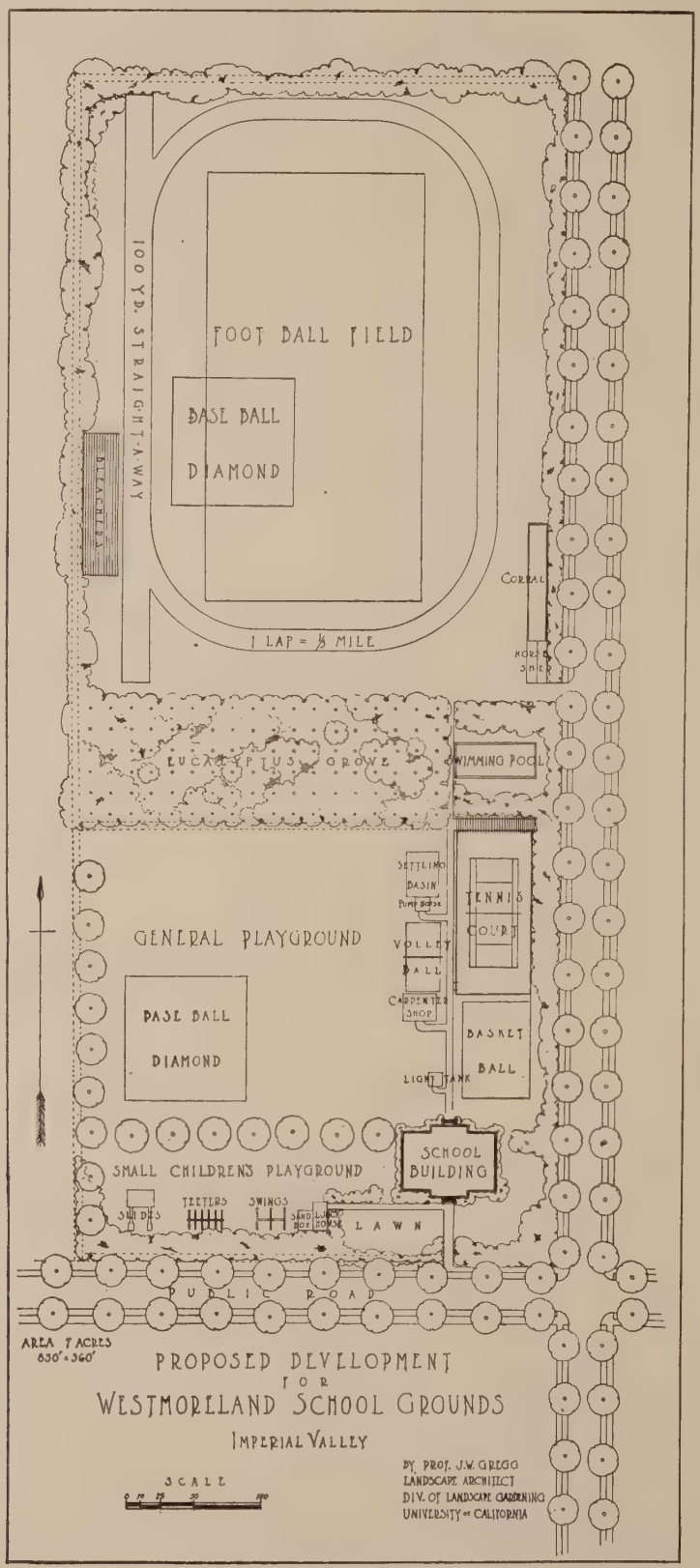

100 YD. STRAIGHT-A-WAY
FOOT BALL FIELD
BASE BALL DIAMOND
BLEACHERS
1 LAP = ¼ MILE
CORRAL
HORSE SHED
EUCALYPTUS GROVE
SWIMMING POOL
SETTLING BASIN
PUMP HOUSE
TENNIS COURT
GENERAL PLAYGROUND
VOLLEY BALL
CARPENTER SHOP
BASE BALL DIAMOND
BASKET BALL
LIGHT TANK
SCHOOL BUILDING
SMALL CHILDRENS PLAYGROUND
SLIDES
TEETERS
SWINGS
SAND BOX
LAWN
PUBLIC ROAD
AREA 7 ACRES
630'×360'
PROPOSED DEVELOPMENT
FOR
WESTMORELAND SCHOOL GROUNDS
IMPERIAL VALLEY
SCALE
BY PROF. J.W. GREGG
LANDSCAPE ARCHITECT
DIV. OF LANDSCAPE GARDENING
UNIVERSITY OF CALIFORNIA

FIG. 65.

other bothersome care. Where space is limited, climbers are the main resource, needing little room but a place in which to root. Many a roughcast building requires the soft lace-work of Boston ivy to relieve its severity. Pergolas and fences are made for roses, wistarias, clematis, trumpet vines, honeysuckle, and jessamine. Here they may run rampant, but on the buildings the sense of structure should not be obliterated by a complete covering of vine growth.

The Border Plantation. — In the consideration of the school front, every effort has been made to produce something beautiful, to stimulate the child's mind to acts worthy of his environment. It is a part of the grounds which he must cherish and protect. The careful mother does not allow her child to enter the drawing-room with muddy feet or to romp there with the dog. So we will inclose the playground. Let us do this by means of a fence, strong and permanent. Usually no great expense need be lavished upon mere ornament, for the fence should be screened from outside view, with foliage. Let the fence be set back some six to twelve feet from the property line to allow for a border of shrub plantation. Especially necessary is this along the street fronts. There are many valid reasons for such a screen. All playground authorities agree that the fence permits of better supervision and protection of property. From the outsider's point of view the expanse of bare ground of the playground field is not very pleasing, nor does it tend to raise property values in a choice residence section. By providing for the ornamental frame outside the fence, the school presents to the public an entirely attractive appearance.

From the inside point of view, the border of planting does much to produce the effect of group solidarity. A little domain is hereby set aside for single-minded enjoyment of play. Without self-consciousness the boy or girl may exercise in hygienic attire. Besides this, the scene of play activity is redeemed from its severity of setting by the beauty of the encircling foliage. Where space is limited the border can be restricted to a narrow strip providing enough room for vines or for a single hedge outside the fence. This is of course not so fine as the broader treatment. The fence should return at a point usually in line with the main rear wall of the building. The border planting then merges easily into the front parking.

The Value of Landscape Architecture. — The school of the future will no longer tolerate the shortcomings of the past. A realization of the value of beauty has developed in modern education. The mass of the people is already alive to the value of beauty in school buildings, and it will not be long before the larger unity of architecture and grounds is understood by all. The landscape architect will become a necessary associate to the architect. Each will have appreciation of the work of the other.

By this valuable coöperation there will result a harmonizing of color, line, and texture, and with such a well-considered environment the child will be developed along these physical and mental lines, that will so satisfactorily affect his growth and development.

CHAPTER IV

COST OF SCHOOL BUILDINGS

By John J. Donovan, B.S., *Architect*, A.I.A.

Costs of School Buildings. Requirements for a Low Elementary School. Requirements for a High Elementary School. Requirements for Junior High and Pre-Vocational School. Data for a General or Inclusive High School. Methods of Computing Costs. Cost Per Classroom. Cost Per Pupil. Cost Per Square Foot of Floor Area. Cost Per Cubic Foot. Cubic Contents. Types of Construction. Class A. Class B. Class C. Class D. Class E or Frame Construction. Classification of Heating and Ventilation. Grades. Sanitary Installations. Electrical Installations. Classification of the Educational Grades. The Elementary School. The Junior High School. The High School.

Table No. 1, Approximate Costs per Cubic Foot for Class A, B, and C Buildings. Table No. 2, Approximate Costs Per Cubic Foot of Different Grades of School Buildings. Table No. 3, Approximate Costs Per Cubic Foot for Different Grades of Heating and Ventilating Systems. Table No. 4, Approximate Costs Per Cubic Foot for Plumbing and Electrical Installations.

Cost of Equipment. Cost Data for a Proposed High School. Comparative Costs and Records.

Table No. A, Form of Record. Table No. B, Subdivision of Costs of Contracts.

Static Capacity. Static Capacity of Building. American Institute of Architects' Classification of School Buildings and Construction.

Costs of School Buildings. — There are two distinct purposes in seeking to determine the costs of school buildings: one to enable boards of education to provide with some degree of accuracy sufficient funds for the erection and equipment of new buildings, and the other to determine, by comparison with the costs of similar structures before the board has obligated itself by contracts, the economy to be exercised in the planning and construction of the proposed work. The former is essential to good business management, and the latter is a necessary precaution against extravagance.

There have been more disappointments, misunderstandings, and loss of confidence through injudicious expenditure of money for the building of schools than in all other transactions by boards of education. This condition is largely due more to the indefinite methods employed at the early stages of the undertakings than to any other cause. It is not to be expected that elected members of boards of education should know how to unravel and classify the maze of details related to this work, as they are usually of the laity and therefore unacquainted with the vast educational and building minutiæ which go to make up the whole.

However, since they are morally, socially, and politically responsible for providing and expending the funds, it is all-essential that they have prepared for them definite data setting forth the necessary contents of the building, the character of the construction, the grade of the sanitation, the system of heating and ventilation, and the facts relating to the other building appointments before establishing the budget for the proposed structure. This requires close collaboration among members of the board, its officers and the architect.

The following lists of requirements for the low and high elementary, the junior high, and the senior or regular high schools are offered as indicative of the necessity of having a definite scheme prepared before attempting to compute the costs of a school building. Deductions or additions may be made to suit the particular problem of each community.

REQUIREMENTS FOR A LOW ELEMENTARY SCHOOL, GRADE I TO VI INCLUSIVE

1. *Principal.*
   - (*a*) Office — telephone and programs systems, fire alarm.
   - (*b*) Toilet.
   - (*c*) Storage space.
   - (*d*) Library for text books.
2. *Teachers.*
   - (*a*) Rest room, (*b*) Lunch room, } combined.
   - (*c*) Kitchen.
   - (*d*) Toilet.
   - (*e*) Wardrobes or closets.
3. *Medical Department.*
   - (*a*) Emergency room.
   - (*b*) Toilet.
4. *Mechanical Department.*
   - (*a*) Boiler room (isolated).
   - (*b*) Fan room.
   - (*c*) Work and repair room.
   - (*d*) Incinerator.
   - (*e*) Janitor's closet on each floor.

   Note: The above rooms should be of fireproof construction.

5. *Pupils' Service.*
   (*a*) Bicycle rooms.
   (*b*) Toilet rooms (on each floor)
   (*c*) Playrooms, boys and girls.
   (*d*) Showers, boys and girls.
6. *Department of Instruction.*
   (*a*) Classrooms — wardrobes.
   (*b*) Kindergarten — wardrobes and toilets.
   (*c*) Drawing room for V and VI grades.
7. *Assembly Hall.* (Seating 60 per cent of the school capacity.)
   (*a*) Stage — dressing rooms.
   (*b*) Moving picture booth.

REQUIREMENTS FOR A HIGH ELEMENTARY SCHOOL GRADES I TO VIII INCLUSIVE

1. *Principal Suite.*
   (*a*) Public office, waiting room.
   (*b*) Private office.
   (*c*) Toilet.
   (*d*) Storage.
   (*e*) Telephones — program system — fire alarm.
2. *Library.* For text books and about 1000 reference and fiction books.
3. *Teachers' Suite.*
   (*a*) Rest room.
   (*b*) Lunch room, kitchenette.
   (*c*) Toilets.
   (*d*) Wardrobes.
4. *Medical Department.*
   (*a*) Emergency room.
   (*b*) Examination rooms.
   (*c*) Toilet rooms.
   (*d*) Girls' rest room.
5. *Mechanical Department.*
   (*a*) Boiler room (isolated).
   (*b*) Fan rooms.
   (*c*) Work and repair room.
   (*d*) Storage room.
   (*e*) Incinerator.
   (*f*) Janitor's room on each floor.

   } Fireproof construction.
6. *Pupils' Service.*
   (*a*) Bicycle rooms.
   (*b*) Toilet rooms (on each floor).
   (*c*) Playrooms (boys and girls).
   (*d*) Swimming (possible).
   (*e*) Showers (boys and girls).
   (*f*) Dressing rooms.
   (*g*) Athletic-field rooms.
7. *Gymnasium.*
   (*a*) Dressing rooms
   (*b*) Showers

   } If there is a swimming pool one set will do for both pool and gymnasium.
   (*c*) Instructor's room.
   (*d*) Examination rooms.
   (*e*) Apparatus room.
8. *Department of Instruction.*
   (*a*) Classrooms — wardrobes.
   (*b*) Kindergarten — wardrobes.
9. *Home Economics.*
   (*a*) Cooking room.
   (*b*) Dining room.
   (*c*) Pantry.
   (*d*) Sewing room.
   (*e*) Fitting room.
   (*f*) Locker room, supplies.
10. *Manual Training.*
    (*a*) Bench room.
    (*b*) Lumber room.
    (*c*) Finishing room.
    (*d*) Painting room (fireproof).
    (*e*) Small fireproof room for storage of painting materials.
11. *Drawing.*
    (*a*) Freehand.
    (*b*) Mechanical.
12. *Music.*
    (*a*) Choral room.
    (*b*) Small practice rooms (dressing rooms off stage serve well).
    (*c*) Office for storage of instruments, music sheets, books, etc.
13. *Assembly Hall.*
    (*a*) Main room to seat about 60 per cent of the school capacity.
    (*b*) Stage — with dressing rooms.
    (*c*) Moving picture booth.
14. *Science Department.*
    (*a*) Laboratory for general science.
    (*b*) Storeroom.
    (*c*) Germinating room.
15. *Commercial.*
    (*a*) Bookkeeping.
    (*b*) Commercial geography.

REQUIREMENTS FOR JUNIOR HIGH AND PRE-VOCATIONAL SCHOOL, ACCOMMODATING 1200 STUDENTS

ADMINISTRATION:

1. *Principal.*
   (*a*) Public office.
   (*b*) Private office — telephone program system, fire alarm.
   (*c*) Storage space.
   (*d*) Toilet room.
   (*e*) Vault for school records.
2. *Large Storage Room:*
   (*a*) Books.
   (*b*) Charts.
   (*c*) School supplies.
3. *Medical Department.*
   (*a*) Emergency room.
   (*b*) Examination rooms.
   (*c*) Toilet.
4. *Teachers' Accommodations.*
   (*a*) Teachers' room (men) lockers.
   (*b*) Toilet room.
   (*c*) Teachers' room (women).
   (*d*) Wardrobe closets.
   (*e*) Toilet room.
   (*f*) Lunch room.
   (*g*) Kitchenette.
5. *Mechanical Department.*
   (*a*) Boiler room (isolated).
   (*b*) Fan rooms and plenum chambers.
   (*c*) Fresh air intakes.
   (*d*) Possibly air washer, generally not needed (depending on location of building).
   (*e*) Switchboard room.
   (*f*) Work and repair room.
   (*g*) Storage room.

(*h*) Incinerator.
(*i*) Janitor's closet on each floor.
Note: The above should be of fireproof construction.

6. *Pupils' Service.*
(*a*) Bicycle rooms, boys and girls.
(*b*) Locker rooms, off corridors, boys and girls.
(*c*) Toilet rooms, on each floor, boys and girls.

7. *Department of Instruction.*
Two study rooms to accommodate $\frac{1}{4}$ to $\frac{1}{3}$ of student body.
Library: Close to study rooms.
(*a*) Art alcoves and exhibition room.

8. *Classrooms.*
16 to 20 major period classrooms depending on school enrollment and judgment of the superintendent.
Plan of building should be so designed that this department may be increased, as occasion or conditions warrant, without destroying the symmetry of the general plan.
Size of classrooms should be determined by the superintendent of schools, that is, the maximum capacity. Would recommend that classrooms for Junior High School do not exceed 35 seats.
Certain rooms should be designed for emergency of 45 seats.

9. *Commercial Department.*
(*a*) Bookkeeping room.
(*b*) Small banking space at end of bookkeeping room.
(*c*) Typewriting space.
(*d*) Office and storage rooms.

10. *Home Economics.*
(*a*) Two domestic science rooms (cooking rooms).
(*b*) Pantry and storage rooms.
(*c*) Small dining room (for training in service).
(*d*) Lockers.
(*e*) Domestic arts (sewing and dressmaking).
(*f*) Millinery room.
(*g*) Design and drawing room.
(*h*) Housekeeping suite { living room, dining room, kitchen, small laundry, toilet.
This might well be a small inexpensive cottage near school.
The living room may serve as Mothers' Club meeting room.

11. *Industrial Arts Department.*
(1) Mechanical drawing rooms.
(2) Free hand drawing rooms.
(3) Manual training room with a small amount of woodworking machinery, such as:
(*a*) A planer, joiner, hand-saw, circular saw, and grinder, and about 24 benches.
(*b*) Also one additional bench room of 24 benches.
(*c*) Lumber room.
(*d*) Gluing room (small).
(*e*) Painting and finishing room.
(*f*) Tool room.
(*g*) Storage room for finished work.
(4) General shop for some machine shop work, electrical work, plumbing, sheet metal, etc. This shop should be equipped with a little of everything, so that the boy may feel his way towards the work leading to a vocation.
(5) Wash, toilet, and locker rooms arranged for common use by students in both shops.

12. *Music Department.*
(*a*) Large choral room treated for good acoustics, which may be used for orchestral and band practice.
(*b*) The supervisor of music may recommend another similar room for the orchestra and band, in which case they could be so placed that (*a*) and (*b*) may be combined.
(*c*) A few small practice rooms.
(*d*) Office and space for storage of instruments, music sheets, books, etc.
(*e*) The choral room could be used for training in dramatics and expression.
(*f*) A large visual instruction room (moving pictures and stereopticon).

13. *Assembly Hall.*
(*a*) Assembly Hall to seat 10 per cent more than school capacity and so arranged that it may be divided into three halls by use of roller curtains. (See Assembly Hall Plans in Chapter on Assembly Halls.)
(*b*) Stage adaptable for scenery, possibly a loft and gridiron.
(*c*) Moving picture equipment.
(*d*) Dressing rooms.

14. *Gymnasium.*
(*a*) Gymnasium.
(*b*) Showers — boys and girls.
(*c*) Locker rooms.
(*d*) Dressing rooms, toilets.
(*e*) Apparatus room.
(*f*) Instructors' offices.
(*g*) Examination rooms.

15. *Science Department.*
(*a*) Three general science laboratories.
(*b*) Germinating rooms (conservatory).
(*c*) Storeroom (large) with cases especially designed.
(*d*) Work and repair room, not very large.

Inasmuch as all three (7th, 8th, and 9th) grades will take this course, which embraces Physical Geography, Biology, Physiology, Botany, Elementary Chemistry, and Elementary Physics, there should be at least three and possibly four main General Science Laboratories with the attendant accessory rooms as listed under (*b*), (*c*), and (*d*).

Note: Extension of this Department should be determined by the superintendent of schools, who may consider it advisable to add small Chemistry and Physics laboratories.

DATA FOR A GENERAL OR INCLUSIVE HIGH SCHOOL ACCOMMODATING 1500 TO 2500 PUPILS

ADMINISTRATION:

1. *Registrar's Office.*
(*a*) Large working and waiting room.
(*b*) Vault for school records.
(*c*) Storage space.
(*d*) Wardrobe closets.
(*e*) Program system.
(*f*) Telephone system.
(*g*) Teachers' time clocks.

2. *Principal* (Day School).
(*a*) Private office.
(*b*) Toilet.
(*c*) Storage space.
(*d*) Consultation room (small).

3. (*a*) *Two vice-principals' offices, private* { dean of boys, dean of girls.
(*b*) Waiting rooms.
(*c*) Toilets.

(*d*) Storage spaces.
(*e*) Girls' rest room near office of dean of girls.
(*f*) Toilets.

4. (*a*) Principal (evening school).
(*b*), (*c*), (*d*) same as vice-principal's suite.
5. Storage space (books, charts, documents, general school supplies, vault).
6. *Medical Departments.*
(*a*) Emergency room.
(*b*) Examination room.
(*c*) Waiting rooms, boys' and girls'.
(*d*) Toilet rooms.
7. *Teachers' Department.*
(*a*) Teachers' room (men).
(*b*) Locker room.
(*c*) Toilet room.
(*d*) Teachers' room (women).
(*e*) Locker room.
(*f*) Rest room.
(*g*) Toilet room.
Note: For lunch room see chapter on cafeteria.
8. *Mechanical Plant.*
(*a*) Boiler and pump room (isolated from building).
(*b*) Fan rooms and plenum chambers.
(*c*) Fresh air intakes.
(*d*) Air washers (depending on location of building).
(*e*) Switchboard room (preferably in electrical shop).
(*f*) Work and repair room.
(*g*) Storage room (supplies).
(*h*) Incinerator.
Note: The above should be housed in fireproof construction, and possibly in a separate building called "Power Plant."
(*i*) Janitor's closets on each floor.
9. *Pupils' Service.*
(*a*) Bicycle rooms or space (boys' and girls').
(*b*) Locker rooms (boys' and girls').
(*c*) Toilet rooms (boys' and girls') on each floor.
(*d*) Rooms for officers of school government.
(*e*) Students coöperative book store.
10. *Cafeteria.*
(*a*) Lunch rooms (boys' and girls') seating 900 at a time.
(*b*) Serving space.
(*c*) Large kitchen.
(*d*) Scullery and garbage rooms.
(*e*) Storage rooms and refrigerators.
(*f*) Toilets for help (men and women).
(*g*) Wardrobe for help (men and women).
(*h*) Separate lunch room for teachers.
11. *Service Department.*
(*a*) General help room.
(*b*) Toilets.
(*c*) Supply storage.
12. *Assembly Hall.*
(*a*) Room so arranged it may be divided into three halls. Floor sloping. Seats fixed.
(*b*) Stage with gridiron.
(*c*) Dressing rooms.
(*d*) Moving picture booth.
(*e*) Property room.
13. *Gymnasiums.* (Boys' and girls'.) Near athletic field.
(*a*) Large gymnasium, divided by curtains and so it may be thrown into one or two rooms.
(*b*) Directors' rooms (men and women).
(*c*) Dressing rooms and locker rooms.
(*d*) Examination rooms.
(*e*) Shower baths (boys' and girls').
(*f*) Toilets (boys' and girls').
(*g*) Storage for equipment.
(*h*) Gallery and running track.
(*i*) Swimming pool.
14. *Library.*
(*a*) Large reading room (capacity for 10,000 to 20,000 books).
(*b*) Librarian and work or repair room.
(*c*) Possibly a stack room.
(*d*) Seating capacity at least 6 per cent of the enrollment.
(*e*) Lecture and museum room.
15. *Department of Instruction. Academic.*
(*a*) Class or recitation rooms. The size and number should be determined by the Superintendent of Schools, but would recommend at least 24 exclusive of classrooms in other departments.
The general plan should be so drawn that extensions could easily be added without destroying the symmetry of the scheme and so that the future classrooms would be adjacent to the section built at this time.
(*b*) Three study halls, each approximately 30′×65′, seating about 120 students. These study halls should be divided in two by means of folding doors or rolling partitions so that when desired they could be converted into classrooms.

COMMERCIAL DEPARTMENT

16. *Bookkeeping.*
(*a*) Three or four classrooms seating 36 each.
(*b*) Teachers' office connected with each room.
(*c*) Storage rooms.
(*d*) Arithmetic classrooms.
(*e*) Law and commercial geography classroom.
(*f*) Room for banking divided into saving, school banking, and national banking.
(*g*) One classroom for penmanship.
(*h*) Room for mechanical accounting.
17. *Shorthand and Typing.*
(*a*) Three or four rooms for typing.
(*b*) Three rooms for shorthand.
(*c*) Room for duplicating and multigraphing.
(*d*) Offices for teachers.
(*e*) Storage rooms.

SCIENCE DEPARTMENT

18. *Chemistry.*
(*a*) Three chemistry laboratories, each accommodating 24 students.
(*b*) Offices and storage rooms.
(*c*) Two lecture rooms, seating about 50 to 60.
(*d*) One dark room (for photography).
(*e*) Balance room (isolated).
(*f*) One special laboratory (not very large) fitted for special work such as assaying and for instructors' special work.
19. *Other Science Laboratories.*
(*a*) Biology laboratory.
(*b*) Botany laboratory.
(*c*) Conservatory of fairly good size.
(*d*) Physiology laboratory.
(*e*) Physical geography and map room.

(*f*) General science laboratory.
(*g*) Lecture room seating about 60.
(*h*) Office for each instructor.
(*i*) Large storeroom for each laboratory.
(*j*) Preparation rooms for instructors, for each laboratory or between laboratories.
(*k*) Possibly a general museum for use by all the above laboratories.

Note: For economy (*a*), (*b*), and (*d*) could be combined and possibly (*e*) and (*f*).

20. *Physics.*
(*a*) Two large physics laboratories (mechanics and electrical).
(*b*) One lecture room seating approximately 60.
(*c*) One preparation room between laboratories.
(*d*) Three large apparatus storage rooms.
(*e*) One repair room.
(*f*) One office.
(*g*) One wireless telegraphy room.
(*h*) One advanced physics laboratory.

Home Economics

21. *Cooking.*
(*a*) Three domestic science rooms (cooking). (One elementary and two advanced.)
(*b*) Pantries and storage rooms between.
(*c*) One general dining room.
(*d*) Wardrobes and lockers for aprons and dresses.
(*e*) Two offices.
(*f*) Classroom or demonstration room.
(*g*) Hygiene.

22. *Sewing.*
(*a*) Two dressmaking rooms: fitting rooms, wardrobes, locker rooms.
(*b*) One millinery room.
(*c*) One costume-designing room.
(*d*) One laundry, fairly large room with apparatus for washing and drying.
(*e*) One exhibition room.
(*f*) Storerooms and offices.

23. *Homemaking rooms.*
(*a*) Living or dining room combined or separate as instructor would direct.
(*b*) Kitchenette and pantry.
(*c*) Bedroom.
(*d*) Bath and toilet room.

This could very well be a cottage near the school and especially designed for this course.

24. *Drawing and Art Department.*
(*a*) Two large freehand drawing rooms.
(*b*) Storage rooms.
(*c*) Two offices.
(*d*) Water color room.
(*e*) Storage and office.
(*f*) Four mechanical drawing rooms.
(*g*) Offices and record room.
(*h*) Clay modeling and pottery room (small).
(*i*) Clay storage room.
(*j*) Small room for finished work.
(*k*) Exhibition and art room for display of finished work of the above classes, centrally located, also for hanging paintings and placing sculpture.

25. *Music Department.*
(*a*) Large choral room.
(*b*) Storeroom.
(*c*) Two classrooms for the study of harmony and history of music.
(*d*) Large room for orchestral and band practice and should be adjacent to the choral room so that both may be joined for joint practice and study. Double soundproof doors and walls between these rooms. Both rooms should be treated so that the acoustics are favorable for the work within.
(*e*) Four or five small practice rooms for instrumental music.
(*f*) Arrangement for the storage of instruments, music stands, music sheets, books, etc.

26. *Industrial Arts. Shops.*
(1) Automobile shop.
(*a*) Storage.
(*b*) Tool room.
(*c*) Instructor's office (small).
(2) Machine shop.
(*a*) Storage for raw material.
(*b*) Tool room.
(*c*) Office.
(*d*) Storage for finished work.
(3) Forge shop.
(*a*) Blower and exhaust room.
(*b*) Tool room.
(*c*) Storage for raw material.
(*d*) Storage for finished work.
(*e*) Office.

Note: The automobile, machine, and forge shops should be close together, as there is a continuity in their work and there may be a saving in tools and equipment.

(4) Carpentry, woodworking machine, cabinet, and pattern shops.
(*a*) Lumber rooms.
(*b*) Tool rooms.
(*c*) Gluing rooms.
(*d*) Painting and finishing rooms.
(*e*) Paint cabinets, fireproof.
(*f*) Storage rooms for finished work.
(*g*) Sawdust and shavings extractor room and tank.
(5) Electrical shop with main switchboard controlling entire plant.
(*a*) Store and supply rooms.
(*b*) Office.
(*c*) Tool room.
(*d*) Room for lighting fixtures in finished state (walls and ceiling).
(*e*) Apparatus room.
(6) Plumbing, sheet metal, and masonry shop.

This shop should be higher in height so that rough plumbing may be carried up through three low stories and false roof in order that the work may be practical.

(*a*) Large storerooms for the three trades.
(*b*) Office.
(7) Foundry with a cupola.
(*a*) Pattern storage room.
(*b*) Coke, iron, and brass storeroom.
(*c*) Core room and core oven.
(*d*) Office.
(8) General lecture or demonstration room.
(9) Exhibition room for the best work of students. This will stimulate interest in the work.

(10) There should be wash and locker rooms between every two shops, also toilet rooms and a shower room near the foundry and close to the forge, automobile, and machine shop.

(11) Printing plant.

(*a*) Editorial room (school paper).

(*b*) Office for instructor.

(*c*) Storage rooms for supplies.

27. A swimming-pool is listed as a suggestion; and if a Board deems it advisable it should be placed near the gymnasium, so that the one set of showers, dressing and locker rooms for each of the sexes could very well be used, thereby economizing in plumbing equipment and floor space. Should this physical education feature be adopted it would be advisable for the department to install its own water system.

28. It might be advisable for a Board to install an electrical generating system, for lighting and power, as high-pressure boilers will have to be installed in any event for heating. Also a school of this character will be attended by evening or continuation students during the entire school year. And the cost of maintenance may be kept at a minimum.

29. *Athletic Field.*

(*a*) One-fourth of a mile track.

(*b*) Bleachers.

(*c*) Small part of main building for emergency room, apparatus, and tools.

Methods of Computing Cost. — Several methods are used in arriving at the proposed cost. These will be discussed in the order of their merit and accuracy. More often than otherwise no well-developed method at all is followed; but a lump sum is arbitrarily fixed upon without due regard to its adequacy or economy. After its adoption, either by budget or bond election, when it is found that the money will not meet the requirements, the necessity of having an intelligent and reliable preliminary estimate based on the actual needs is usually acutely apparent.

Cost Per Classroom. — The almost obsolete rule of thumb method of computing the preliminary estimate by assuming a unit cost per classroom based on the cost per classroom of some other school building is no better than hazardous guessing. Seldom, if ever, are the actual facts known that ruled the requirements, contents, construction, prevailing prices of labor and material, and many other building conditions which governed the planning, erection, and cost of the previously erected building taken as a guide.

The site has much to do with the cost of the building. A level tract of firm ground, where it is necessary to carry the foundations down to only a reasonably safe depth, will give advantages in cost per classroom as against a sloping site which necessitates substructures or extended foundations and retaining walls before the actual building can be started. The orientation of the lot, since it means a great deal to the orientation of the building and its various rooms, will affect the costs, as will the size and number of the rooms used for instruction together with their related rooms.

The differences in heating and ventilating systems and their costs are as varied as the types of construction of buildings. This is true of the plumbing, electrical work, blackboards, hardware, finish, etc. Consequently, any computation based on a unit cost of classrooms cannot lead to accuracy, as there are so many other factors entering into the problem.

Cost Per Pupil. — For the same reasons the cost per pupil is not sufficiently definite to warrant fixing an estimate by which to build, although such an attempt is one step better than trying to reach an estimate based on the cost per classroom.

An example will help to make these conditions clear. Let us assume a proposed school that at completion will provide accommodations for x number of pupils, but the overhead rooms and special departments, such as administration rooms, assembly hall, toilet rooms, boiler and fan rooms, domestic science, laboratories, etc., etc., are of the minimum size and yet are adequate to provide instruction for $x + y$ pupils, which very likely will be the number a year or two after the building is completed. The question naturally arises upon which number of pupils shall the cost be based. If based on x, the cost per pupil must be higher than if figured on $x + y$, and yet all the essentials except the additional rooms for instruction may be included in the original scheme. And since there is no way of striking a prospective average upon which to compute the total cost on a cost per pupil basis until the plant has reached its final growth, it is unsafe to base estimates from this standpoint, although it is well to have such a record when the building is completed.

Furthermore, for comparison, this method is not reliable unless all the facts are known, for one school may have an assembly hall, playrooms, gymnasium, swimming-pool, etc., while another may have some of these rooms but not all of them, and they may be of smaller size and not as well equipped; or again they may not have any of them. Also the cost per pupil in one case may include the grading, planting, walks and fences of the grounds, and preparation of the athletic field, while these may be omitted altogether from another. Consequently the cost per pupil should be used only as a relative check after other and more definite measures and methods have been taken to determine the cost.

When boards of education or architects are vying with each other on the low costs of school buildings per classroom and per pupil, it is reasonable to assume that the educational facilities, the health conditions, and the structural permanency of the building and its

finish are being curtailed or slighted in order to make a political or professional showing on the credit side of their ledger, a result which never atones for failure to do full justice to the problem.

Cost per Square Foot of Floor Area. — This method in estimating the cost of a proposed building is not sufficiently accurate, as it does not involve the cubic contents of the building. For instance, the school building under consideration may have approximately the same floor area as another and at the same time may have greater story heights and a high sloping roof. This difference would immediately upset and make void any careful calculation of the proposed or comparative cost. Unit cost per square foot is of very little help, and should be only obtained for the additional information it affords in tabulating the different unit costs of the structure.

Cost per Cubic Foot. — Next to having actual estimates of the quantities and costs of materials and labor involved, the method of computing the cubic contents of the building and establishing a reasonable unit of cost per cubic foot is undoubtedly the best. Before this cost can be determined, it is necessary to have preliminary drawings of the entire plant, which drawings should clearly indicate the location and quantity of fixed equipment, the general treatment of the grounds, and also a definite understanding of the type of plan and the class of construction, while the equipment and furniture will not be considered at this time, although the final computation will necessarily include these items.

Cubic Contents. — When considering the different types of buildings it is not so easy to define just what the cubic contents should include so as to have a unanimity of opinion, but most authorities agree on the following methods.

For buildings more than one story in height the cubic contents should be the summation of the products of the following:

The area of the ground space occupied by all portions of the building measured to its outside walls, multiplied by the height of these portions measured from a point 6″ below the top of the lowest floor level to the average roof level. This shall include all covered or inclosed stoops, penthouses, covered steps or entrances, arcades, chimneys to roof levels, etc. Actual cubage of open stoops, steps, walls, and floor slabs of open areas should be figured solid. Where portions of the building are built to different heights, each portion should be taken as an individual unit and the rule as above applied. The average roof level is intended as the mean of sloping or pitched roofs, and the top of flat roofs. All parapet walls should be figured solid. The sum total will be the cubage of the building.

Whenever unusual conditions prevail requiring rock excavation, piling, retaining walls, extraordinary foundation work, sheet-piling, or special work in excess of the ordinary foundation work required for a building on a level tract of firm bearing soil, these conditions should be taken into account and figured separately from the normal cubage. They are usually listed under the heading of abnormal costs.

With one-story buildings having no basements, except boiler-room space, and the main floor level about two or three feet above grade level, there is a great diversity of opinion as to the method to be employed. The mooted question is regarding the space between the floor and the top of the ground. Having built a number of schools of this type, the author is of the opinion that the most reliable method is to figure the foundations, walls and piers solid to the under side of floor construction, and then add the cubic contents of the remaining part of the building as in the two- or three-story structures. To include the space under the floor the same as that above it is misleading, as no finish is used below the floor.

Mr. Edward C. Baldwin, Secretary Massachusetts State Board of Education, in a very able paper presented before the National Association of School Accounting Officers at St. Louis, May 19, 1918, recommended that "the cubical contents of the building should be defined to mean the cubical contents of the space or the rooms actually used or available for school purposes, such for example as classrooms, coatrooms, assembly halls, corridors, stairways, playrooms, offices, lunchrooms, sanitaries, storerooms, engine and boiler rooms, coal rooms, stack rooms, fan rooms, etc., but should not include attic spaces, or other parts of a building which cannot be used for school or its related work."[1]

This is an admirable suggestion for purposes of comparison after the building is completed, but for preliminary cost purposes, it seems to the author as though it is more valuable to compute the cost by a unit cost per cubic foot multiplied by the total cubage of the building, plus the cost of any special work.

Types of Construction. — After having the educational requirements established and recorded by the preliminary drawings and the cubage obtained, the next step should be to determine upon the unit cost per cubic foot. Before doing this it is necessary to know what type of construction shall be adopted, what system of heating and ventilation is to be installed, and the quality and finish of the other building installations. For sequence the types of construction should be classified

[1] American School Board Journal, 1918.

into grades adopted by the building laws of cities. In some cities they are rated numerically as Class 1, 2, 3, mill, and ordinary frame construction; and in others they are rated alphabetically as Class A, B, C, mill, ordinary and frame construction. For purposes herein they will be graded alphabetically.

Class A. — Class A is a building built with a steel frame supporting all walls, floors, and roofs, and the structural parts, such as partitions, exterior, and interior walls, floors, stairs, etc., built of fire-resisting materials except that the finish floors, windows, trim, and doors may be of wood construction. Schools not over three stories high would not necessarily have the exterior walls supported by the steel frame, as they could with safety and economy be self-supporting and also support the adjacent floor loads. Buildings of more than three stories in height and built within the fire limits, in order to comply with the building ordinances of many cities, are required to have the windows, trim, and doors of metal or metal covered.

Class B. — Buildings of this class are built with the walls of masonry or concrete supporting the adjacent floor loads, and with reënforced concrete columns supporting the interior portions of the floors; the floors, roofs, and structural parts of reënforced concrete, masonry, or other fireproof construction. Doors, trim, windows, and floors are of wood. For school buildings, this class might be extended so that interior partitions between rooms for defined areas (about 2500 square feet) could be built of wood studs and wood lath for the acoustical quality these materials give to the classrooms. The partitions inclosing these areas and the corridor partitions should be of fireproof materials.

Class C. — For schools, this class of buildings should be defined as having the exterior walls of masonry or reënforced concrete; the corridor floors and stairways of reënforced concrete, supported by steel, cast iron, or reënforced concrete columns; the remaining floors of wood construction; the interior walls of wood studs and wood lath, except the corridor walls, which should be of metal lath construction, and the floors, trim, etc., etc., of wood. It should be noted that this is somewhat differently defined from that of the usual Class C construction found in building ordinances; and it is specially mentioned as suggesting a safe middle course for the building of schools, when classes A and B are found to be too expensive. This type is favorable for school buildings outside the fire limits and not more than three stories high.

Class D. — This class differs from Class C only in not having the walls and floors of the corridors and the stair wells of fireproof construction. In this class the wood floors may be supported by a steel frame, a concrete frame, a timber frame or by wood studs. The exterior walls are of masonry construction. This type of construction for schools should be limited to buildings of two stories.

Class E or Frame Construction. — A Class E building is constructed entirely of wood. A school of frame construction should not be more than two stories high.[1]

Classification of the Heating and Ventilation. — Having classified the construction, the next step should be to classify the permanent mechanical installations, such as the heating and ventilation systems. If they are graded numerically, it will avoid confusion with the grading of the types of construction.

Heating and Ventilation, Grade I. — This grade includes a steam boiler plant, mechanical stokers, or oil burning systems, the dual system of heating and ventilating, that is, radiators and the air of the plenum system tempered, air washers, temperature, and humidity controlled by thermostats, and vacuum pumps for the return system.

Heating and Ventilation, Grade II. — The same as Grade I without the direct radiation. In this grade, the heating of the rooms is done by means of heating the air supply to such temperature that the heated air comfortably warms the rooms. It should be carefully recorded whether or not the system includes an air washer and mechanical stokers, as these installations affect the cost of the plant.

Heating and Ventilation, Grade III. — This grade consists of a hot air furnace, replacing the steam plant mentioned in Grade I and II and which heats the building similarly to the means of Grade II. There is a temperature control but no air washer or mechanical stokers to this system. It should be noted that this method of heating is very inferior to I and II.

Heating and Ventilation, Grade IV. — This grade consists of a steam plant furnishing direct radiation only to the classrooms; such rooms as the assembly hall and large study room are supplied with tempered air. It also includes temperature control. Like Grade III such a system is applicable only to sections of the country having climates where open windows are permissible the year round.

Sanitary Installations. — It is assumed that in this day and age only good sanitary fixtures would be used, consequently there would be little or no difference in the total costs of the different classes of construction, unless a septic sewage system or a water supply system are required. Then the cost of these items should be taken into account.

Electrical Installations. — The principal items to take account of here are whether or not the lighting fixtures should be installed at the time of construction,

[1] In classifying the different types of construction it has been assumed that for all classes the boiler rooms are of fireproof construction.

and should program clocks and bells, fire alarm system and intercommunicating telephones be provided. It is assumed that all wiring shall be of the metal conduit method, and comply with the rules of the National Board of Fire Underwriters.

Classification of the Educational Grades. — A further classification of building is necessary to fully comprehend and solve fully the problem of costs. For it is evident to those at all familiar with schools that the senior inclusive, or cosmopolitan high school with built-in equipment will cost more per cubic foot than the low elementary school of the same class of construction.

Any number of classifications of schools might be formed, but the main point is to keep these somewhat technical matters simplified so that it is not difficult for the layman to follow the modus operandi and know how to act intelligently and logically when the facts are placed before him.

The following is suggested as a simple classification:

The Elementary School.

1. Lower elementary, grades I to VI inclusive without assembly hall.
2. Same with assembly hall.
3. Upper elementary, grades I to VIII inclusive, with rooms for cooking, sewing, manual training, and assembly hall. If the school has a gymnasium or a swimming-pool special mention should be made of the facts. But as a general rule the average upper elementary school does not have these features.

Junior High School.

The High School. — It is not so simple a matter to classify the high school, as secondary educational systems are constantly changing by the additions of new subjects or courses and consequently new and different rooms and equipment. The classical or purely academic high school containing classrooms, assembly hall, gymnasium, library, and laboratories for the elementary sciences is fast being supplanted by the inclusive high school with all kinds of shops, laboratories, rooms for household arts and commercial instruction in addition to the rooms or departments included within the scope of the classical high school. Therefore, any classification will require supplementary data regarding the rooms for special study or work. Furthermore, the method of handling study classes, whether in special study halls or in classrooms under the supervision of the class teacher, is quite likely to affect the plan and the cubic contents of the building; it would be well to have the method fully understood before determining on a unit cost.

However, the following is offered as a suggestion as to classification to be amplified according to the prevailing conditions.

1. Classical high school.
2. Commercial high school.
3. Technical high school.
4. Inclusive or cosmopolitan high school embodying 1, 2, 3, and
5. Vocational or trade schools.
6. High school with dormitories.

(See Elko, Nevada, High School plan.)

Having thus classified the construction, the heating and ventilating systems, and the types of buildings, for use it is possible then to proceed to quote costs per cubic foot from work executed prior to the war as a basis from which to work. It should be borne in mind that immediate post-war prices and conditions are unstable and will remain so for some time. Consequently the unit figures given below are based on ante-war costs. Until the world has readjusted itself to the new order of conditions, reasonable margins for safety should be allowed in all estimating. The fluctuations and prices of both labor and materials must also be considered. The furniture and equipment should not be included in obtaining the net cost of the building, nor should the walks, approaches, grading, and landscape work be included, as exceptionally expensive work may be required for filling, surfacing, and planting. Therefore the grading should be figured separately.

The following tables have been compiled from a collection of data dating back to 1910.

Table No. 1 is a compilation from the school records of the different localities. It should be noted that certain classes of construction are lower in one section than in another, while another class of construction in the same locality is higher in unit cost due to the remoteness of the structural materials from the source of supply. This also accounts for the range of unit costs given in Table No. 2.

In like manner, it should be remembered that heating and ventilating will vary in cost according to the climatic and seasonal conditions of the different localities. For instance, heating should cost more in Massachusetts, New York, Illinois, and Missouri than it does in California. This is somewhat true of plumbing as well, for less covering of pipes against frost is required in the last locality than in any of the previously mentioned states.

Due to the wider use of the high school over that of the elementary, the unit costs of the electrical work are correspondingly higher. Also the electrical installations in the shops, laboratories, etc., of the junior, technical, inclusive, and vocational high schools will cause the cost of this work to run considerably higher than that installed in the elementary school, or in the classical or the commercial high school.

It is very important that the reader should remember that any table of costs has only a relative value. Prices change daily, and conditions governed by labor, transportation, etc. will materially affect the cost of building. Therefore the writer submits the following tables, with this caution of their use.

TABLE NO. 1. — APPROXIMATE COSTS (IN CENTS) PER CUBIC FOOT FOR CLASS *A* BUILDINGS WITH CLASS *I* HEATING AND VENTILATING AND FULL ELECTRICAL INSTALLATION.

LOCALITY	COST PER CU. FT.	COST OF GEN. WORK PER CU. FT.	COST OF H. & V. PER CU. FT.	PLUMBING PER CU. FT.	ELEC. WORK PER CU. FT.
Boston	22 to 25¢	18 to 20¢	2 to 3¢	1.1 to 1.5¢	.8 to 1.9¢
Chicago	17 to 20¢	13 to 16¢	2 to 3¢	1 to 1.5¢	.25 to .4¢
St. Louis	17 to 20¢	13 to 16¢	2½ to 4¢	¾ to 1.2¢	½ to 1¢
San Francisco	19 to 23¢	16 to 19¢	1 to 1.5¢	.7 to 1.3¢	½ to 1¢

CLASS *B* BUILDINGS CLASS *I* (HEATING AND VENTILATING) AND FULL ELECTRICAL EQUIPMENT.

Boston	19 to 24¢	17 to 20¢	2 to 3¢	1.1 to 1.5¢	.8 to 1.9¢
Chicago	16 to 19¢	13 to 15¢	2 to 3¢	1.0 to 1.5¢	.25 to .4¢
St. Louis	16 to 20¢	12 to 15¢	2½ to 4¢	¾ to 1.2¢	½ to 1¢
San Francisco	16 to 19¢	12 to 15¢	1 to 1.5¢	.7 to 1.3¢	½ to 1¢

CLASS *C* BUILDINGS CLASS *II* (HEATING AND VENTILATING) AND FULL ELECTRICAL EQUIPMENT.

Boston	17 to 24¢	14 to 20¢	1.7 to 2.7¢	Same as above	Same as above
Chicago	15 to 18¢	12 to 15¢	1.6 to 2.8¢		
St. Louis	15 to 18¢	13 to 15¢	1.8 to 3¢		
San Francisco	14 to 17¢	11½ to 14¢	1 to 1.5¢		

TABLE 2. — APPROXIMATE COSTS (IN CENTS) PER CUBIC FOOT FOR DIFFERENT GRADES OF SCHOOL BUILDING CONSTRUCTION.

TYPE OF SCHOOL	CLASS A	CLASS B	CLASS C	CLASS D	CLASS E
1 Low elementary without assembly hall	20 to 26¢	18 to 23¢	16 to 20¢	14 to 18¢	13 to 17¢
2 Same with assembly hall	18 to 24¢	17 to 23¢	15 to 20¢	14 to 18¢	13 to 16¢
3 Upper elementary	19 to 24¢	18 to 22¢	15 to 20¢	15 to 19¢	13 to 17¢
4 Junior high school	20 to 24¢	17 to 23¢	15 to 20¢	15 to 19¢	This is problematical
5 Classical high school	20 to 24¢	18 to 23¢	17 to 21¢	16 to 20¢	as there are
6 Commercial high school	20 to 24¢	18 to 23¢	17 to 21¢	16 to 20¢	very few ex-
7 Technical high school	21 to 26¢	18 to 24¢	17 to 22¢	16 to 21¢	amples of
8 Inclusive high school	21 to 26¢	18 to 23¢	16 to 21¢	15 to 20	this type of
9 Vocational or trade school	22 to 26¢	18 to 24¢	17 to 23¢	16 to 22¢	construction
10 Dormitories	25 to 30¢	23 to 27¢	20 to 25¢	19 to 23¢	for these buildings.

TABLE 3. — APPROXIMATE COST (IN CENTS) PER CUBIC FOOT FOR DIFFERENT GRADES OF HEATING AND VENTILATING SYSTEMS FOR SCHOOLS.

TYPE OF SCHOOL	GRADE I COMPLETE	GRADE II PLENUM ONLY	GRADE III HOT AIR FURNACE	GRADE IV RADIATION ONLY
Elementary	2 to 3¢	1.5 to 2.5¢	0.8 to 1.5¢	0.7 to 1.2¢
High school	1.5 to 2.5¢	1 to 2¢	0.7 to 1¢	0.5 to 1.5¢
Dormitories	Should not install plenum		1.2 to 2¢	1. to 1.5¢

TABLE 4. — APPROXIMATE COSTS (IN CENTS) PER CUBIC FOOT FOR PLUMBING AND ELECTRICAL INSTALLATIONS IN THE DIFFERENT CLASSES OF EDUCATIONAL BUILDINGS.

TYPE OF SCHOOL	PLUMBING	ELECTRICAL
Elementary	½ to 1.2	½ to 1
Junior high school	¾ to 1.3	¾ to 1.3
Classical or commercial high school	¾ to 1.3	¾ to 1.2
Technical high school	¾ to 1.4	¾ to 1.9
Inclusive high school	¾ to 1.5	1 to 2
Vocational high school	¾ to 1.5	1 to 2
Dormitories	1.2 to 1.7	1.5 to 2.5

NOTE: — The increased cost in building in 1920 is approximately 150 per cent higher than in 1914.

There should be some check on the cost per cubic foot method in order to insure against a low unit cost per cubic foot and at the same time a high cubage per pupil. The compact or closed type of school will show a smaller cubage per pupil, while the open or spread-out type will require a greater allowance. The one-story schools will show a decided increase over that of the two- or three-story schools.

The compact elementary school with classrooms and a very few accessory or related rooms will require from 600 to 800 cubic feet per pupil, while the open type will need from 900 to 1100 cubic feet, showing a wide divergence. Similarly the two types of high schools will show a wide variance in cubage per pupil. In five recently built high schools constructed in different sections of the country, the lowest cubage was 1200 cubic feet per pupil, while the highest was slightly more than 2700 cubic feet per pupil. Naturally the cost per cubic foot was much lower in the latter. Yet from the two plans, the school with the higher cubage per pupil contained more rooms for educational and physical advantages than the high school of the lowest cubage.

The writer has built a number of one- and two-story schools of the Class C construction which cost between eleven and fourteen cents per cubic foot, but they were of the open type, and their unit cost is not recorded in Table No. 2, as such figures undoubtedly would be misleading, the cost per pupil being about normal.

Inasmuch as the tendency is towards the open type of plan for both the elementary and high school, the data at hand are not sufficient to warrant establishing a limit to the cubage per pupil. Also the hygienic advantages of the open plan for sunshine and natural ventilation are so pronounced that it is hard to believe, notwithstanding the desire to economize, that the closed scheme would be preferable to the open type when land space is available for the latter.

However, when the combined floor area of the rooms for instruction is appreciably less than 50 per cent of the total floor area of the building, then it is time to look for extravagance or waste in the planning of areas.

Rooms for instruction should include classrooms, laboratories, library, shops, home economics rooms, rooms for commercial work, drawing, and any rooms used for instruction. The question naturally arises, are assembly halls, gymnasia, swimming-pools, etc., in the category of instruction rooms? Generally they should not be included, but should be classified as rooms related to instruction rooms.

Cost of Equipment. — It is most essential that a reliable estimate be obtained, showing the cost of the furniture and equipment, before school boards establish a figure covering the cost of the proposed school. Very often this important item is overlooked until the building is completed, and then it is found necessary either to call for additional funds or to install worn-out and disfigured furniture and equipment entirely inadequate to meet the needs of the school. Stock furniture can be purchased more cheaply than it can be designed and specially made. And undoubtedly it will be better built and generally of a finer design. But equipment for science laboratories, household arts, library bookcases, and similar equipment should be designed by the architect, in collaboration with the heads of the different departments, as the needs and requirements of each school can be accommodated better by this method *than by attempting to make the school meet the requirements of stock equipment.*

The following preliminary estimate was prepared by the writer for the Board of Education of a city of 20,000 inhabitants in California, in February, 1917, prior to the bond election for a new high school. This enabled the Board to go before the electors with definite data regarding the proposed building. This, together with the preliminary drawings, demonstrated a businesslike procedure which has had a marked influence upon other communities. At least the "rough-shod," hazardous guess is absent.

It should be carefully noted that this estimate applied to a distinct group of buildings for a community having a number of special problems involved. For another city or district, distinctly different conditions might govern the plan, the amount and character of the equipment, and the materials entering into the construction. Consequently the unit costs and the prices quoted would naturally change. The data are submitted to indicate the necessity of having a thoroughly prepared estimate of the cost of the furniture and equipment, without which it is impossible to clearly present the facts of the case to the people so that they may vote intelligently on the expenditure. It will be found more favorable to the building of schools if people are enlightened to the fullest extent on these matters prior to the time of taking the first important step.

ESTIMATED COST OF BUILDING AND EQUIPMENT OF PROPOSED HIGH SCHOOL FOR CITY OF (X)

I *Buildings Only* February 2, 1917

DESCRIPTION	SIZE	STORIES	AREA	HEIGHT	CUBAGE	UNIT COST	TOTAL ESTIMATED COST
A Main building . . . . Contains: Principal's suite, Vice principal's suite, Women teachers' rest room, Men teachers' room, 16 Classrooms, School paper room, Library, Reading and magazine room, Commercial Department, Typewriting room, Bookkeeping room	65′×250′	2	32,500	36′	585,000	$0.16	$93,600.00
B Assembly hall . . . . Contains: Auditorium, 65′×100′, Stage, 60′×30′, Seats 1000 people, Music department		1	8,300	36′	298,800	0.14	41,832.00
C Science building . . . Contains: 2 Chemistry laboratories, 1 Chemistry lecture room, 1 Store room for chemical supplies, 1 dark room, 1 Biology laboratory, 1 Store room for biological supplies, 1 Physics laboratory, 1 Small laboratory and store room, 1 Physics lecture room, 1 General science laboratory, 1 General science storeroom	70′×150′	1	10,500	20′	210,000	0.14	29,400.00
D Shop building . . . . Contains: 1 Recitation room, 1 Bench and lathe room, 1 Forge room, 1 Machine shop, 1 Mechanical drawing room, 1 Freehand drawing room, 1 Auto shop	70′×150′	1	10,500′	20′	210,000	0.14	29,400.00
E Home economics building Contains 1 Domestic science room, 1 Domestic arts and crafts room	70′× 80′	1	5,600′	20′	112,000	0.14	15,680.00
F Gymnasium . . . . . Contains 1 Boys' locker room, 1 Girls' locker room, 1 Boys' shower room, 1 Girls' shower room, 1 Main hall	50′×100′	1	5,000′	33′	165,000	0.14	23.000.00
G Cafeteria . . . . . Contains: Kitchen and service space sufficient to accommodate 312 persons	52′× 84′	1	4,368′	20′	87,360	0.13	11,356.00
H Miscellaneous . . . . Landscaping, planting, preparation of site and other non-comparable items							13,000.00
Total cost of buildings without equipment . .							$257,268.00

II ESTIMATED COST OF EQUIPMENT

	DESCRIPTION			
H	Main building			
	Principal's suite			
	1 Roll-top desk	$40.00		
	1 Desk chair	8.00		
	5 Visitors' chairs @ $4.00	20.00		
	1 Settee	35.00		
	1 Rug	40.00		
	1 Center table	20.00		
	1 Filing cabinet	35.00	$198.00	
	Vice principal's suite			
	1 Flat-top desk	40.00		
	1 Revolving chair	7.00		
	2 Visitors' chairs @ $6.00	12.00		
	1 Drop-lid typewriter desk	35.00		
	1 Typewriter chair	7.50		
	1 6′ library table	40.00		
	Filing cases	100.00		
	1 Rug	35.00	276.00	
	Women teachers' rest room			
	1 Couch	30.00		
	4 Wicker chairs @ $9.00	36.00		
	3 Wicker rockers @ $10.00	30.00		
	1 Table	25.00		
	1 Writing desk	20.00		
	1 Rug	35.00	176.00	
	Men teachers' rest room			
	Same as above		176.00	$826.00
	Classrooms			
	30 Movable chairs @ $7.50	225.00		
	1 Revolving chair	7.00		
	1 Visitors' chair	6.00		
	1 Teacher's desk	20.00		
	16 Classrooms	$258.00	$4,128.00	
	School paper room			
	2 Flat-top desks @ $20.00	40.00		
	2 Chairs @ $6.00	12.00		
	3 6′ tables @ $25.00	75.00	127.00	
	Library			
	5 3′×5′ Tables @ $20.00	100.00		
	30 Chairs @ $6.00	180.00		
	1 Book exchange desk	30.00		
	1 Revolving chair	7.00	317.00	
	Note: Bookshelves will be built in.			
	Reading and magazine room			
	1 Newspaper file	15.00		
	3 3′×5′ tables @ $20.00	60.00		
	18 Chairs @ $6.00	108.00		
	2 Magazine racks @ $20.00	40.00	223.00	
	Commercial Department			
	Typewriting Room			
	40 Typewriter desks @ $25.00	$1,000.00		
	40 Typewriter chairs @ $2.50	100.00		
	1 Instructor's desk	35.00		
	1 Instructor's chair	7.00	1,142.00	
	Note: No machines included.			
	Bookkeeping room			
	35 Bookkeeping desks @ $25.00	$875.00		
	35 Bookkeeping chairs @ $2.50	87.50		
	1 Instructor's desk	35.00		
	1 Instructor's chair	7.00	1,004.50	
	Total for main building			7,767.50
	Assembly hall			
	Auditorium			
	1,000 chairs @ $4.50	$4,500.00	$4,500.00	
	Stage			
	12 Platform chairs @ $7.00	84.00		
	1 Pedestal stand	20.00		
	Stage curtains	500.00		
	Stage scenery (1 set)	450.00	1,054.00	
	Music department			
	Allow	$400.00	400.00	5,954.00
	Note: Piano not included			
	Science Building			
	2 Chemistry laboratories @ $2,500.00	$5,000.00	$5,000.00	
	1 Chemistry lecture room			
	1 Instructor's table	300.00		
	48 Chairs @ $4.00	192.00	492.00	

	DESCRIPTION			
H	Science Building — *Continued*			
	1 Biology laboratory			
	Allow	$1,800.00	$1,800.00	
	1 Small physics laboratory			
	Allow	$1,000.00	1,000.00	
	1 Physics laboratory			
	Allow	$2,000.00	2,000.00	
	1 Physics lecture room			
	1 Instructor's table	$300.00		
	48 Seats @ $4.00	192.00	492.00	
	1 General Science laboratory			
	Allow	1,800.00	1,800.00	$12,584.00
	Shop Building			
	Recitation room			
	36 Movable chairs @ $7.50	$270.00		
	1 Instructor's desk	20.00		
	1 Instructor's chair	7.00	297.00	
	Bench and lathe room			
	18 Woodworking benches @ $50.00	$900.00		
	6 13″×55″ Lathes @ $90.00	540.00		
	6 ½ Horse-power motors @ $40.00	240.00		
	1 36″ Band saw with 5 horse-power motor	420.00		
	1 Universal bench saw with 5 horse-power motor	650.00		
	1 30″ Planer with 15 horse-power motor	1,180.00		
	1 16″ Jointer with 5 horse-power motor	250.00		
	1 Sander with 5 horse-power motor	382.00		
	1 Grinder with ½ horse-power motor	150.00	4,712.00	
	Forge shop			
	6 Pair forges @ $130.00	$780.00		
	1 Exhauster with 7½ horse-power motor	330.00		
	1 Blower with 2 horse-power motor	100.00		
	1 Smoke separator	250.00		
	12 Sets forge-shop tools, anvils, and accessories	476.00	1,936.00	
	Machine shop			
	8 14″×72″ Lathes with motor drives @ $1,076.00	8,608.00		
	1 16″ Shaper with 3 horse-power motor	700.00		
	1 30″×30″×10″ Planer with 5 horse-power motor	1,800.00	6,945.00	
	Machine shop (continued)			
	1 22″ Drill press with 1 horse-power motor	$263.00		
	1 Universal milling machine, motor driven	1,680.00		
	1 Sensitive Drill, motor driven	94.00		
	1 Shear	75.00		
	1 Emery wheel grinder	40.00		
	1 Hack saw	30.00	13,290.00	
	Mechanical Drawing Room			
	24 Benches @ $12.00	$288.00		
	24 Stools @ $3.00	72.00		
	1 Instructor's desk	20.00		
	1 Instructor's chair	7.00	387.00	
	Freehand drawing room			
	Same equipment as above		387.00	
	Auto shop			
	1 2-ton chain hoist		45.00	21,054.00
	Home economics building			
	Domestic science room			
	Allow	$1,500.00	$1,500.00	
	Domestic arts room			
	Allow	$650.00	$650.00	2,150.00
	Gymnasium			
	400 Double tier lockers, $7.00	$2,800.00	$2,800.00	2,800.00
	Cafeteria			
	Kitchen equipment	$4,000.00		
	50 Tables @ $10.00	500.00		
	312 Chairs @ $2.00	624.00	$3,124.00	3,124.00
	Recapitulation			$57,433.50
	Cost of buildings	$244,268.00		
	Cost of landscape work, etc.	13,000.00		
	Cost of equipment	57,433.50		
		$314,701.50		

NOTE: — Cost of equipment in 1920 is 150 to 250 per cent higher than in 1917.

Comparative Costs and Records. — It is heartily recommended that accurate records of unit costs of school buildings be kept by boards of education for the valuable information these records provide for estimating and checking up the cost of new plants. Nothing will so quickly indicate waste and unwarranted extravagance as a chart having such data in a ready reference form. There is no doubt in the writer's opinion

that at least a tenth more schools could be built for the money expended in the last fifteen years if such intelligible data were available for reference. It should be observed further that unless the data are reliable they are worse than useless.

The following are two forms of tables of information and cost which should be filled in at the completion of all new buildings and kept in the records of the local board and in the office of the State Superintendent of Education.

TABLE NO. A

1. Name of School.....
2. Location Street.....City.....State.....
3. Date — work commenced Mo.....Yr. .....
   completed Mo.....Yr. .....
4. Educational class.....
5. Class of construction.....
6. System of heating and ventilation.....
7. Total cost.....Normal cost $.....
   Abnormal cost $.....
8. Cubage.....
9. Cost per cubic ft. (*a*) Based on total cost $.....
   (*b*) Based on normal cost $.....
10. Total floor area.....
11. Cost per sq. ft. (*a*) Based on total cost $.....
    (*b*) Based on normal cost $.....
12. Pupil capacity.....
13. Cost per pupil (*a*) Based on total cost $.....
    (*b*) Based on normal cost $.....
14. Static capacity.....
15. Cost per static unit $.....

Note: Enter all items and amounts of abnormal costs below.

TABLE NO. B

Name and grade of school.....
Location.....
Year completed.....
General description.....

Subdivision of Costs of Contracts

Title of Contract	Amount	Cost per Cubic Foot	Cost per Pupil	Cost per Static Unit	
General contract	$	$	$	$	
Heating and ventilating					
Plumbing					
Electrical					
Inspection					
Engineer's fee					
Architect's fee					
Sub-totals					
Furniture and equipment					
Landscape work					
Any abnormal cost (specify)					
Sub-total					
Cost of site					
Number of acres or square feet					
Cost per acre $ or square foot					
Grand total					

Static Capacity. — In a paper read before the National Association of School Accounting Officers on May 16, 1917, Mr. C. L. Wooldridge, then Superintendent of School Buildings, Pittsburgh, Pa., has clearly defined the most accurate method of comparing the cost of school buildings that has come to the writer's attention, and that part defining static capacity is quoted below, with his permission.

"To get this on a fair comparable basis we must find a term which expresses capacity and which can be applied and used to measure every part of a school building which has capacity.

"To meet this need I recommended that the term Pupil Capacity be permanently abandoned and that we substitute therefor the term Static Capacity.

Static Capacity of Building "X"

No.	Name	Static Capacity	Total Static Capacity
16	Classrooms	51	816
16	Coatrooms	50	800
1	Assembly room	700	700
1	Kindergarten	62	62
1	Kindergarten coatroom	60	60
1	Kindergarten workroom	2	2
1	Ungraded room	9	9
1	Cooking laboratory	25	25
1	Cooking laboratory coatroom	24	24
1	Model dining room	6	6
1	Sewing laboratory	25	25
1	Fitting room	2	2
1	Sewing laboratory coatroom	24	24
1	Model bedroom	2	2
1	Domestic science lecture room	25	25
1	Bench room	25	25
1	Bench room coatroom	24	24
1	Wood-finishing room	2	2
1	Drafting room	25	25
1	Drafting room coatroom	24	24
1	Manual training lecture room	25	25
1	Blue-print room	2	2
1	Boys' playroom, 15 square feet per pupil	154	154
1	Girls' playroom, 15 square feet per pupil	154	154
2	Community rooms	100	200
51	Water-closets	1	51
11	Urinals	1	11
36	Washstands	1	36
24	Drinking-fountains	1	24
8	Slop sinks	1	8
1	General office	2	2
1	Private office	1	1
1	Teachers' locker room	24	24
1	Medical inspectors' office	2	2
1	Book storeroom	1	1
	Building contains, static units		3377

$$\frac{\text{Cost, } \$187{,}346.16}{\text{Static units, } 3377} = \$55.47 \text{ per static unit}$$

"By static capacity I mean the total capacity of pupils, teachers, and clerks as applied to every room and department in a school building. For instance, a standard classroom on a fifteen square foot basis will accommo-

date fifty pupils and one teacher, therefore its static capacity is fifty-one. A cloakroom large enough to place the coat hooks far enough apart so that no pupil's coat will touch the coat on the next hook has a definite static capacity. A toilet room has a static capacity equal to the total number of fixtures. An auditorium with twenty-inch seats placed thirty inches back to back and not more than thirteen seats between aisles has a definite static capacity.

"In this way, it is possible to formulate a clean-cut rule for measuring the static capacity of any room in a school building. We will now measure the static capacity of a school building.

"We now have a rule which really considers every element entering into the capacity of the school building:

"In advancing this rule, I do not wish to be understood that my application of it as illustrated above is absolutely right. I merely wish to advance the idea that everything in a building which has to do with its capacity should be considered, and I believe with more careful consideration and study such a rule can be successfully worked out and uniformly applied.

"A complete report for purposes of comparison on a school building would be somewhat as follows:

COMPARABLE DATA

School "X."
District, Pittsburgh.
Year built, 1914.
Educational class, upper elementary.
Construction class, first grade.
Cubage, 1,094,696 cubic feet.
Static capacity, 3377 units.

		Cost per Cu. Ft.	Cost per Static Unit
Cost of general work	$142,091.98	$0.1298	$42.08
Cost of heating and ventilating	29,038.00	0.0265	8.59
Cost of plumbing	10,543.33	0.0096	3.12
Cost of electrical installations	5,672.85	0.0052	1.68
Total	$187,346.16	$0.1711	$55.47

NON-COMPARABLE DATA

Cost of landscaping	$7,547.00	
Cost of abnormal foundations	8,169.00	
Cost of fixed equipment	10,162.45	
Cost of architectural service	12,183.73	
Cost of inspection	3,515.61	
Total	$41,577.79	
Total cost		$228,923.95

"On the assumption that the above rules were in general use, I still feel that comparative costs would not be reliable or authentic unless the rules were applied fairly and impartially. It is possible to apply any rule in a matter of this sort, and by slight variations in its application to get considerable difference in the results." [1]

COSTS

For the following report the author is indebted to Mr. Wm. B. Ittner, Architect, and Chairman of the Committee on "Standardization of School Building Measurements and Cubical Contents," appointed by the American Institute of Architects. This report has been approved by authorized committees from the following organizations:

American Institute of Architects,
National Association of School Accounting Officers,
Committee on Standardization of Schoolhouse Planning, and Construction, National Education Association.

THE AMERICAN INSTITUTE OF ARCHITECTS

REPORT OF THE COMMITTEE ON SCHOOL BUILDING MEASUREMENTS

[To the Fifty-second Annual Convention]

The Committee on School Building Measurements submits the following report:

For the purpose of obtaining comparable data upon the educational utility and cost of school buildings, they shall be classified, measured, and defined as follows:

Educational Classification: School Buildings shall be classified, educationally, as —

Lower Elementary,
Upper Elementary,
High, or Secondary.

Lower Elementary: Shall be defined as a building containing class and kindergarten rooms, together with the usual accessory rooms, such as principal's office, teachers' rooms, playrooms, toilets, etc., and used for the lower elementary grades only.

Should a school building of this type be provided with assembly room, gymnasium, or other special rooms it shall fall into the next classification.

Upper Elementary: Shall be defined as a building containing lower or upper elementary grades, and in addition to the regular class and accessory rooms, an assembly hall, gymnasium, and such special rooms as may be included for upper grade or special work, which may include elementary science, elementary industrial training and household arts.

This classification would thus include the Junior High School, the Elementary Industrial or other types of special elementary schools.

High or Secondary: Shall be defined as a building containing classrooms, recitation rooms, laboratories, and such special rooms as are necessary for classical, technical, industrial, household arts, normal, agricultural, or other purposes required for secondary or junior college education.

Construction Classification

Type A. — A building constructed entirely of fire-resistive materials, including its roofs, windows, doors, floors, and finish.

Type B. — A building of fire-resistive construction in its walls, floors, stairways and ceilings, but with wood finish, wood or composition floor surface, and wood roof construction over fire-resistive ceiling.

Type C. — A building with masonry walls, fire-resistive corridors and stairways, but with ordinary construction otherwise, *i.e.* combustible floors, partitions, roofs and finish.

[1] American School Board Journal, July, 1917.

Type D. — A building with masonry walls, but otherwise ordinary or joist construction and wood finish.

Type E. — A frame building constructed with wood above foundation with or without slate or other semi-fireproof material on roof.

Note: Should buildings of any of the above classifications be erected without complete ventilating systems or other mechanical equipment, due note should be made of such fact in reporting its cost data.

Cost Units

To determine the educational utility of the building, obtain the *cost per pupil.*

To determine construction cost of building, obtain the *cost per cubic foot.*

The divisor to be used to determine the *cost per pupil,* shall be determined by the number of pupils normally accommodated in rooms designed for classes only. In arriving at the number of pupils, special rooms are to be figured at the actual number of pupils accommodated for one class period only. Auditorium or assembly rooms are to be ignored, but gymnasium may be figured for one or two classes, as the accommodation may provide. No gymnasium, however, shall be accredited with two classes, if below 40 by 70 feet in size.

Cost per cubic foot. — To obtain the cube of a school building, multiply the area of the outside of the building at the first-floor level by the height of the building from six inches below the general basement floor to the mean height of the roof. Parapet walls, stacks and other projections beyond the mean height of the roof, as well as balconies and porches not contributing to the actual usable floor of the building, are to be ignored.

Where portions of the building are built to different heights, each portion is to be taken as an individual unit and the rule as above applied.

Cost Items

The cost of school buildings shall be divided into four general items:

First. — Cost of land and grading.

Second. — Cost of building construction.

Third. — Cost of furniture and fixed equipment.

Fourth. — Cost of architects', engineers', brokers' and supervision services.

First. — Cost of land and grading should include the cost of the site and the necessary grading to place it in condition to receive the building. Should the site be abnormal and require piling, filling, quarrying, or other unusual expenditures to place it in normal condition to receive the building, such costs are also to be charged up against the site and not the building.

Second. — Cost of building should include:

(*a*) General contract and any sub-contracts pertaining to the general construction of the building, as, for example, excavating, masonry, fireproofing, steel construction, carpentry, cabinet work, sheet metal work, roofing, painting, etc.

(*b*) All contracts for electrical work, plumbing, vacuum cleaning, sewage disposal, heating and ventilating, clock systems, blackboards, elevators, or any other contract for any part of the building not included above, necessary to complete the same, ready for occupancy.

(*c*) The cost of all site improvements, such as walks, drives, yard paving, fencing, and landscape gardening.

Third. — Cost of furniture and fixed equipment:

(*a*) Should include cost of all portable furniture and cabinets; all laboratory and shop equipment, and all other equipment which would not be classified as "Educational Supplies."

(*b*) All decorations, including special painting or decoration of any kind that may not be included in the general painting contract. Hangings, rugs, pictures, casts, and other forms of decorations furnished at the time of the occupancy of the building which are not classified as "Educational Supplies."

Fourth. — Cost of architects', engineers', brokers', and supervision services should include the cost of all plans and specifications, architects', engineers', landscape gardening and supervision and all other experts' services and expenses.

WILLIAM B. ITTNER, *Chairman.*

CHAPTER V

ORGANIZATION OF THE ELEMENTARY SCHOOL AS AFFECTING BUILDINGS

By E. Morris Cox, A.B., *Assistant Superintendent of Schools, Oakland, California*

Organization of Elementary School. School Site. General Arrangement of Building. Cleanliness. Height of Buildings. Standardization of Classrooms. Special Rooms. Complete Equipment. Physical Education. Health and Sanitation. Arrangement of Classrooms. Visual Instruction. Assembly Hall. Office and Library. Elementary Course of Study.

The Organization of the Elementary School. — The building of school buildings, like most other kinds of building, has usually been carried on without very much consideration as to what is to be done in the building after it is completed. Consequently the buildings are just about as well adapted to the work that is to be carried on in them as are kitchens and office buildings. Of later years occasionally a superintendent or a principal has been consulted in the making of school building plans and as often his advice has been rejected as it has been accepted. Much more often the advice of teachers regarding planning of the interior of a classroom has been heeded. Because of the fact that the advice and counsel of superintendents, principals, and teachers has not usually been sought, very little study or thought has been devoted by them to the problem of school planning, and consequently most of them are not ready with any practical advice. The first thing and the last thing that a school architect or a board of education should do in the planning and erecting of the school building is to seek the advice and counsel of those who are to conduct the school in that building after it is erected.

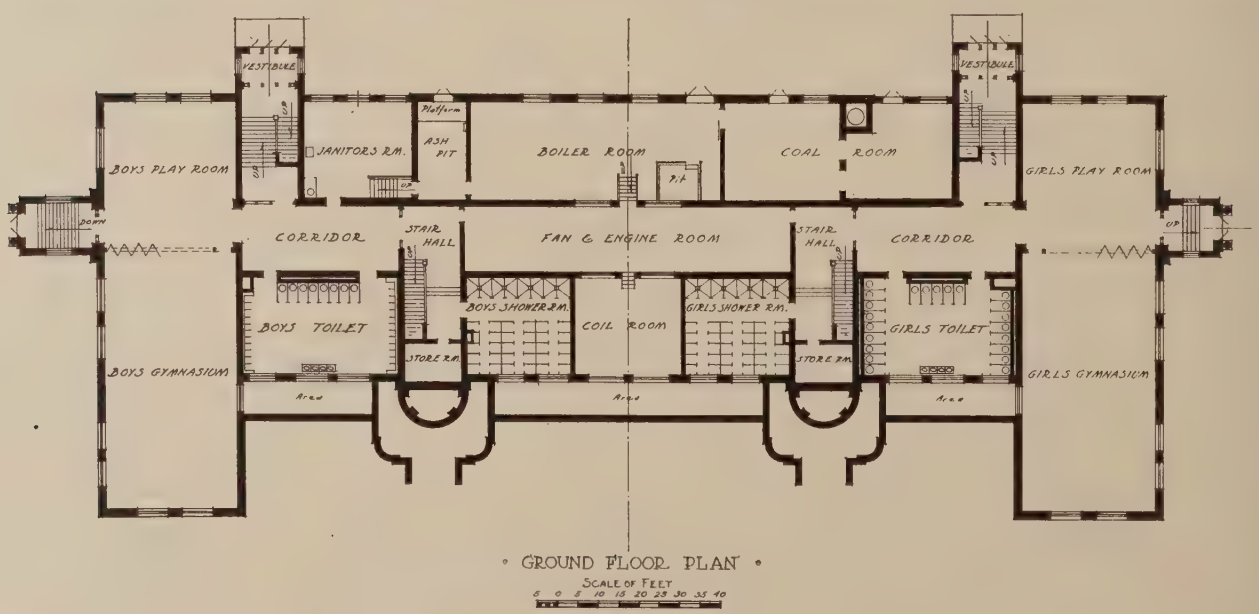
The adaptation of the building to the school organization is more important than any other problem connected with school building. The waste of time and effort and nervous energy due to careless planning or lack of planning is everywhere noticeable to one familiar with the organization and operation of schools.

A School Site. — The size and location of the school site and the location of the building thereon vitally affect the operation of the school. A playground of proper size, properly drained and properly arranged, will to a large degree administer itself. A playground that is too small to accommodate the school or which is not properly adapted to play purposes distracts the attention of principals and teachers from the planning of recreation activities or other school work. Consequently, for administrative reasons, it is important to have the school building properly located, with abundant play space available for both boys and girls, and this play space properly prepared for its purpose. The school building should be near the center of the north side of the grounds so that there may be during the winter season the driest and sunniest part of the school grounds available for play and a fair division of the grounds between boys and girls. There should be at least one-fourth acre for every classroom. This may seem excessive in cities, but our best school systems have brought themselves to it. No city should locate a school building on less than five acres. No one can foretell how soon the day will arrive when there will be a fifteen- or twenty-room building on that site. No effort should be spared to secure the erection of school buildings away from the main arteries of traffic. No one can possibly foretell street development of the future, but it is possible for the authorities at least to avoid locating the school building on the main arteries of traffic already established and oftentimes immediately adjacent to car lines and railways.

General Arrangement of Building. — It is not an uncommon thing to see a school building with steps and doorways so arranged that much unnecessary time is consumed in convening and dismissing school. It is actual economy of time for children and teachers, and therefore economy in education, to plan very carefully the stairs, doorways, and exits for quick and easy entrance and exit to street and playground. It would be easy to record years of lost time because of poor planning in these respects. With an arrangement of halls and stairways which requires thirty seconds of excess time in convening or dismissing a school of five hundred pupils with only four convenings and four dismissals during the day, we have a loss of over thirty-three hours of time per day. Illustrations might be given of school buildings in which the loss of time is two

Mr. Wm. B. Ittner, Architect.

FIG. 66. — LACLEDE ELEMENTARY SCHOOL, ST. LOUIS, MISSOURI.



LACLEDE SCHOOL
ST. LOUIS, MO.
WM. B. ITTNER, ARCHITECT

FIG. 67.

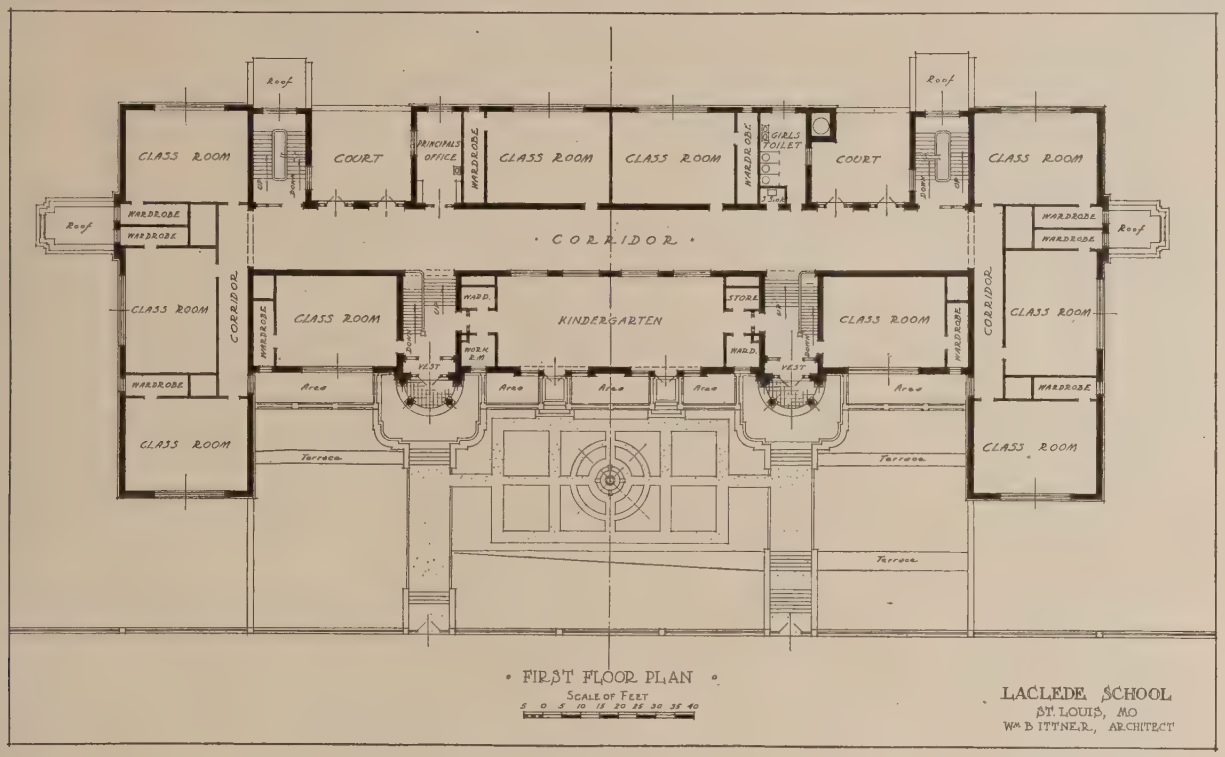
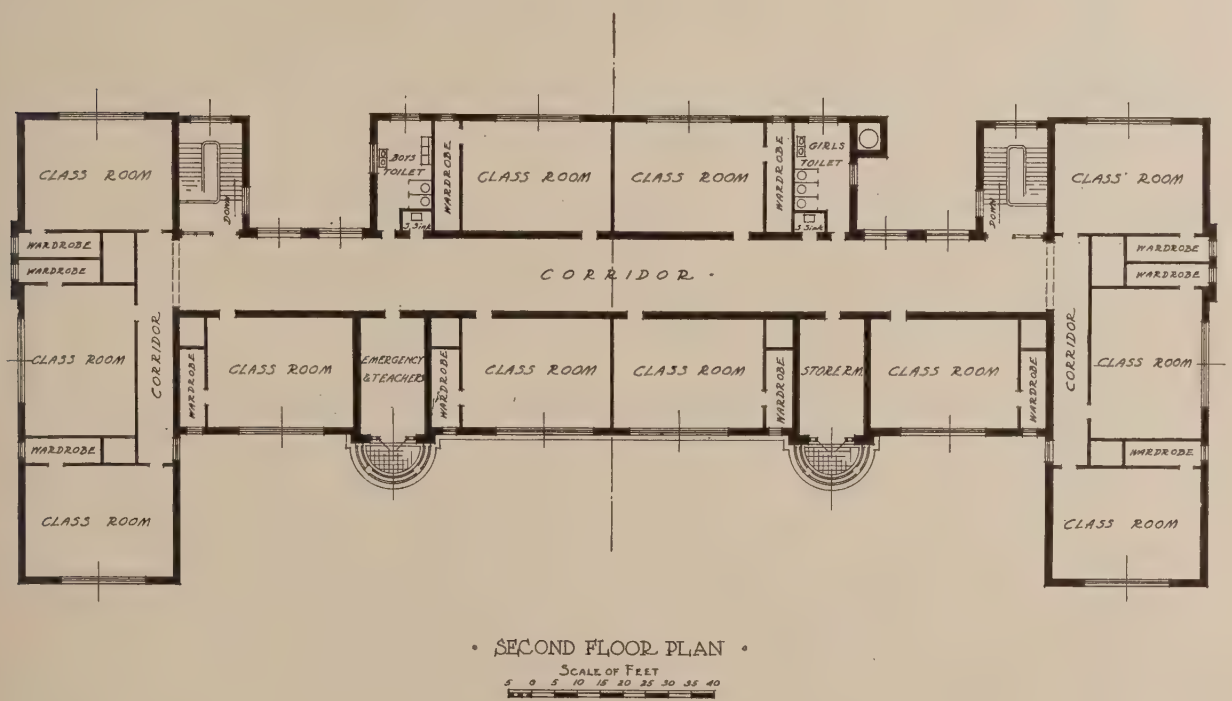


FIG. 68.



LACLEDE SCHOOL
ST. LOUIS, MO.
WM B ITTNER, ARCHITECT

FIG. 69.

or three times this amount. Stairs should be so planned as to bring most direct access between classrooms and playground, and exits should be wide enough to give full capacity to the stairs. The adequacy of stair equipment depends therefore upon both their number and location. There should be no room for dispute as to their sufficiency.

Cleanliness. — Teachers and principals universally will agree that lack of cleanliness of the school building not only endangers the health of the children but interferes with the best operation of the school. School buildings should be planned more carefully to assist in cleanliness. Ledges and moldings and other flat projections should be eliminated. There are but few of them that cannot be abandoned. Rough walls due either to the desire to create a rough surface or to faulty construction are dust and germ collectors. It is actual economy to spend more money in construction that avoids dust collectors rather than to spend it later on the removal of dust.

Height of Buildings. — Administration as well as economical reasons should be urged for building in the most compact form. There are many things that may be said in favor of one-story buildings, but from the administrative point of view one-story buildings beyond perhaps ten classrooms are not desirable. The consensus of opinion of a large number of principals with whom the writer has conferred on this question is in favor of a building with two floors above the ground floor. In this building the indoor playrooms, janitor's rooms, heating apparatus, and the main toilet accommodations should be placed on the ground floor and this should be on the level with the playground. The toilet accommodations should be located particularly convenient to the playground, so that they will be serviceable not only during the school hours but for playground activities conducted outside of school hours. If there is room enough on this floor it will be economical and probably desirable to locate here shops and domestic science rooms. The plumbing can be made more economical, and if properly located there will be less objection to their noise. The kindergarten room may also be properly located on the ground floor, with easy access to the playground.

There are few climates in which covered playrooms are not imperative. Many persons who are not sufficiently familiar with the school problem, and a few who are, have been willing to eliminate covered playrooms. This must always result in children playing in the rooms and corridors during the inclement weather or else not being able to play at all, which is still worse. The elimination of playrooms means the exhaustion of nervous energy of children and teachers which might be much better spent on school work. The covered playroom should be abundantly open to the fresh air. Modern organization of recreational facilities makes it possible to make the indoor playroom take a real part in education.

Standardization of the Classroom. — There has been a growing opinion that the type of classroom of the future has become pretty well fixed. It is fortunate for school architecture that the type of classroom did not become fixed twenty-five years ago at the standards of that time, and it will be probably just as fortunate for the period of twenty-five years hence if the idea of standardization does not get any greater foothold now. Standardization usually means stagnation. The standardized classroom and the obsolete lock-step promotion system go hand in hand. The future elementary school will surely not be classified and graded as is the present elementary school. The future elementary school will have more teachers and more classrooms, therefore, unless we are to build larger buildings, the classrooms may be still smaller. There will be classes of children advancing more rapidly than what we pronounce the normal rate of progress and there will be classes of children who are incapable of doing the regular type of classroom work. Also classes for blind and deaf are often organized. Particularly in upper-grade work, even in the elementary schools including grades higher than the sixth, it will be desirable to have rooms set apart for music and drawing and probably for science. Various schools have made experiments along these lines and some of them have been very successful.

Special Rooms. — So far as the administration of schools is concerned, it is not at all necessary that rooms should be made small, but the modern cost of building demands that the square feet of floor space shall not be greater than is necessary for a proper conduct of the class. The size of the present standard classroom is none too large for the present standard class and is none too large even for smaller classes, therefore, only for economical reasons should smaller rooms for smaller classes be adopted. The music room might readily be combined with the auditorium, provided the auditorium is so constructed as to make it an attractive room suitable for this use. If the auditorium is to be a large one, it will be unsatisfactory for ordinary classroom instruction in music. Ideally, such a room should be about one and one-half to two times the usual sized classroom. It is not in the present development of the subject imperative that there should be a separate room for drawing in the elementary grades, but a room somewhat larger than the regular classroom could be equipped in a manner to make drawing very much more satisfactory even for pupils in the primary grades.

FIG. 70. — CLAWSON ELEMENTARY SCHOOL, OAKLAND, CALIFORNIA.

Mr. John J. Donovan, Architect.

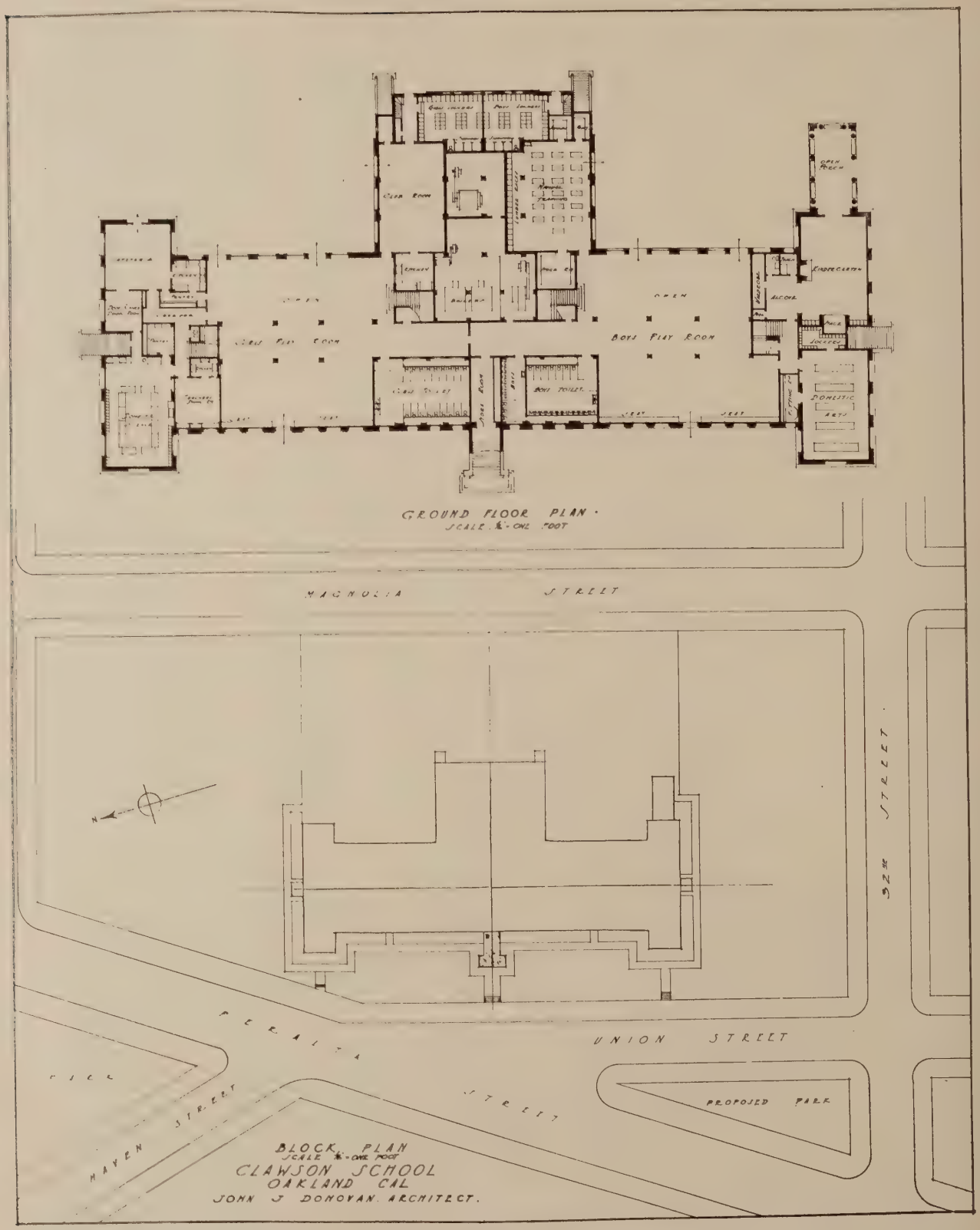
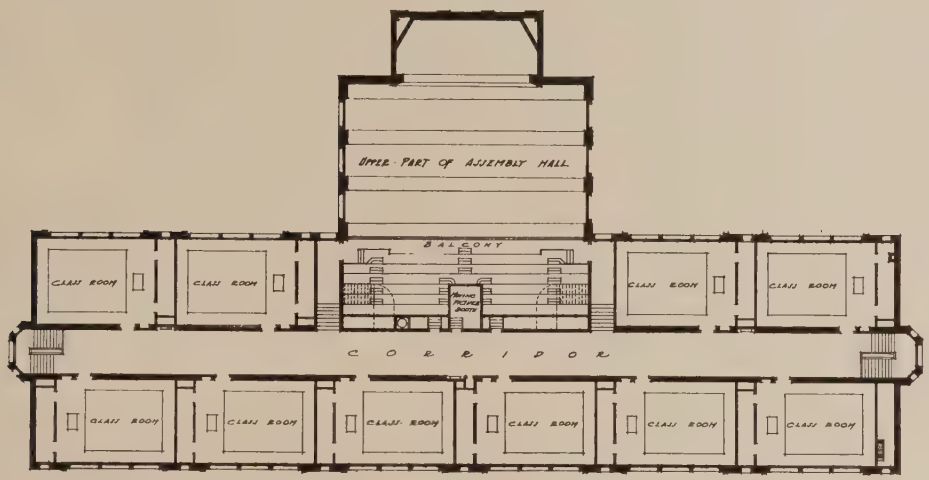
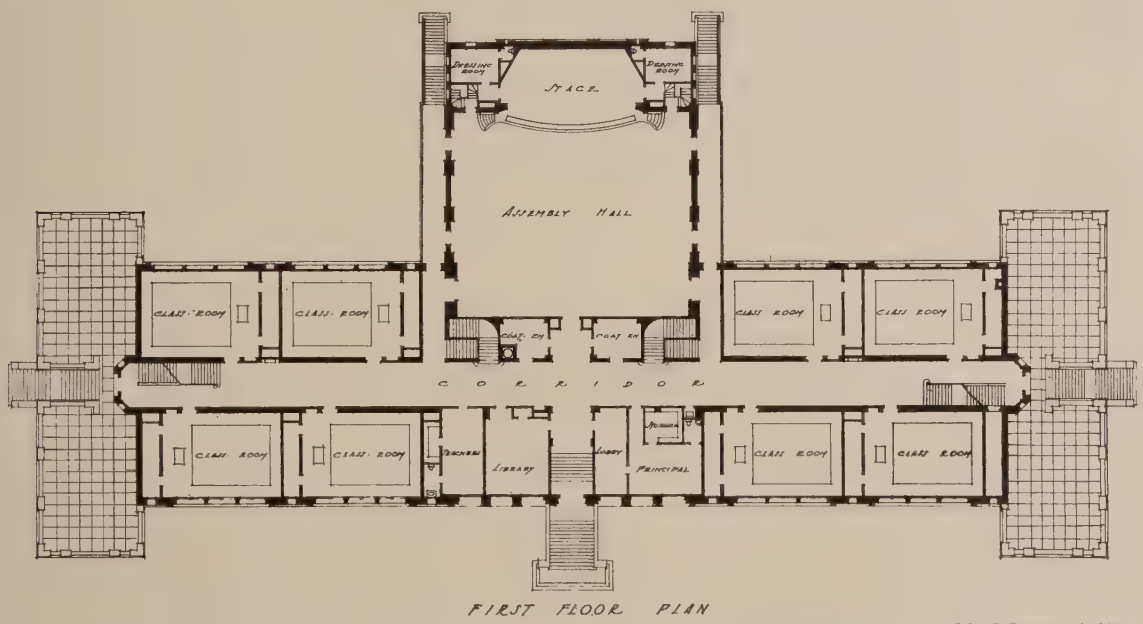

GROUND FLOOR PLAN.
SCALE ⅛" = ONE FOOT
MAGNOLIA STREET
32ND STREET
UNION STREET
PROPOSED PARK
BLOCK PLAN
SCALE ⅛" = ONE FOOT
CLAWSON SCHOOL
OAKLAND CAL
JOHN J DONOVAN. ARCHITECT.

FIG. 71.



SECOND FLOOR PLAN



FIRST FLOOR PLAN

Mr. John J. Donovan, Architect.

FIG. 72. — CLAWSON ELEMENTARY SCHOOL, OAKLAND, CALIFORNIA.

Mr. John J. Donovan, Architect.

FIG. 73. — CLAWSON ELEMENTARY SCHOOL, OAKLAND, CALIFORNIA.

Mr. John J Donovan, Architect.

FIG. 74. — CLAWSON ELEMENTARY SCHOOL, OAKLAND, CALIFORNIA.

Mr. John J. Donovan, Architect.

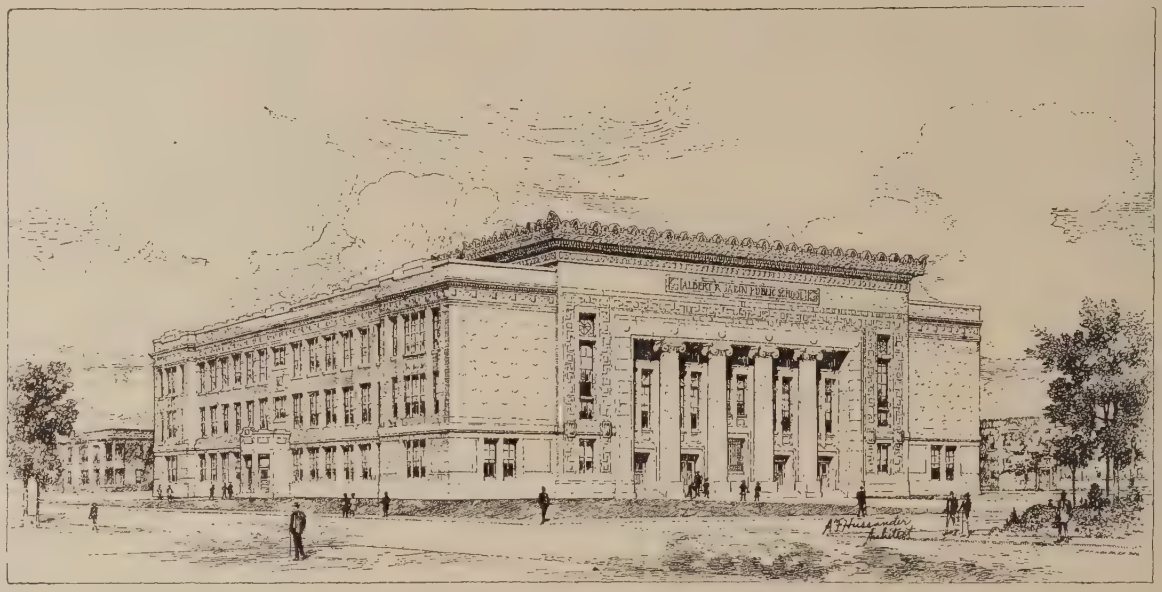
FIG. 75. — CLAWSON ELEMENTARY SCHOOL, OAKLAND, CALIFORNIA.

It is much more difficult to define what the science room ought to be. There is much diversity of opinion. It would seem, however, that in every school there should be a room in which classes in simple experimentation, sand and clay modeling, and other similar work may be conveniently conducted. In such a room the furniture would be chairs and tables, and the room would be supplied with the proper plumbing for water and gas.

Complete Equipment. — It is rather a common practice to exhaust all of the available funds in the building operations, leaving it to the future to provide lighting fixtures, electric bells and clocks, telephones, drinking fountains, cupboards, lockers, bookcases, and such fixtures. This usually results in the school being without these things for a considerable length of time and perhaps forever. It is a prevalent misconception that a good school needs only a good building. Many communities proceed on the theory that because schools have been conducted without such equipment schools still may be so conducted. They do not recognize that the absence of such equipment means the waste of time and effort of those in charge of the school, and therefore must result in less effort and attention being given to the welfare of the youth. It is a difficult thing to learn that there is no economy in doing things wrong. In this connection it should be noted that a school building and grounds that are to be used for recreational facilities are not properly equipped without showers and swimming-pools.

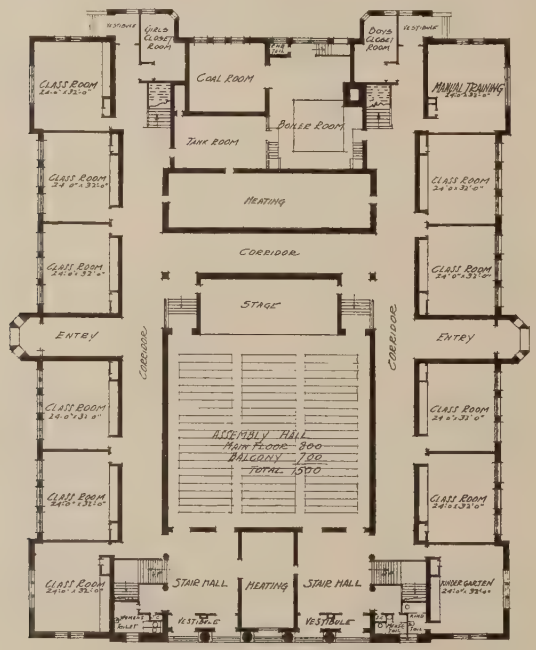
Physical Education. — It should be noted that hereafter the American public is going to demand proper physical education, and that this proper physical education will primarily require outdoor facilities for recreation and indoor facilities consisting of dressing-rooms, showers, and swimming-pools. It will not be high schools only that must have such equipment.

Health and Sanitation. — One room in the building large enough to supply the needs of the health officer in making physical tests should be devoted entirely to the health department, including in its purposes the supplying the school needs for a rest and emergency



ALBERT R. SABIN SCHOOL.
Hirsch and Leavitt Streets, Chicago.
A. F. HUSSANDER, ARCHITECT,
BOARD OF EDUCATION., CHICAGO.
FIG. 76.

room. It should have adjacent to it suitable wash basins and toilet, and the room should be properly furnished for its purposes. The corridors of the buildings should be so constructed as to have permanent outside ventilation. Supplementary toilet accommodations should be located on each wing on each floor. In most climates it would be desirable for construction to be such that every classroom has certain ventilation which cannot be shut off by the teacher.



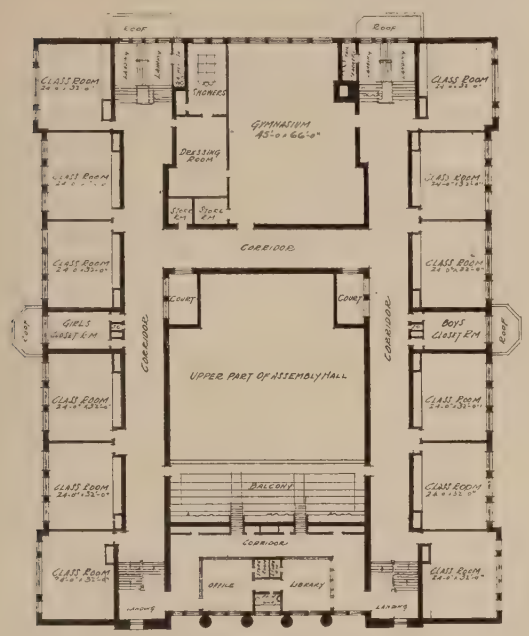
~FIRST FLOOR PLAN~

·ALBERT·R·SABIN·SCHOOL·
·N·LEAVITT·ST.·HIRSCH·ST.·&·N·IRVING·AV·
·A·F·HUSSANDER·· ··ARCHITECT·
·BOARD·OF·EDUCATION·
·CHICAGO·

FIG. 77.

Arrangement of Classrooms. — Considerable care should be devoted to bringing the classrooms for like or similar grades close together. More and more various grades are coöperating in their work. It is, therefore, economy of time and effort to have these grades as near together as possible. The kindergarten should be near the first grade; the first grades should be close together and near the second, and so on throughout the school. It should be noted that the smaller the children the nearer the exits they should be. Consequently, it follows that the upper grades should be on the upper floors. Above the fourth grade at least some of the rooms should be properly equipped for operating stereopticons and projectoscopes to be used in connection with the school work.

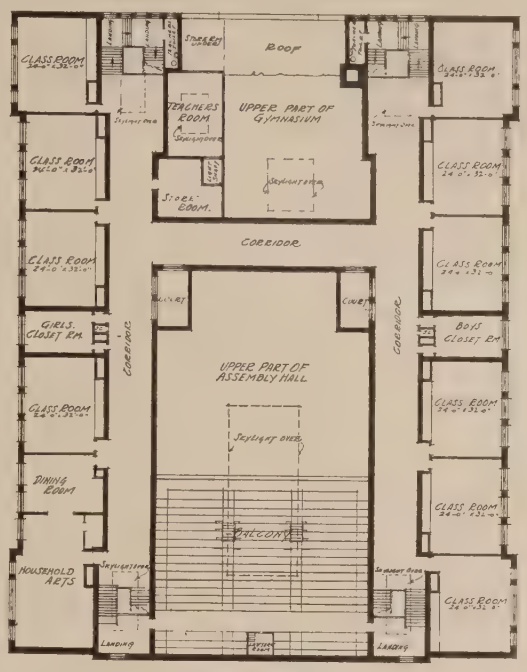
Visual Instruction. — Visual instruction is to play a larger and larger part in the regular school curriculum. Geography and history and nature study and many of the other school subjects will depend materially upon this line of instruction in the future. A very simple equipment can be adopted for some of the classrooms, and a complete moving picture apparatus should be in connection with the assembly hall.



~SECOND FLOOR PLAN~

ALBERT · R · SABIN · SCHOOL
N · LEAVITT · ST · HIRSCH · ST · & · N · IRVING · AV ·
A · F · HUSSANDER · ARCHITECT
BOARD · OF · EDUCATION
CHICAGO

FIG. 78.



~THIRD FLOOR PLAN~

ALBERT · R · SABIN · SCHOOL
N · LEAVITT · ST · HIRSCH · ST · & · N · IRVING · AV ·
A · F · HUSSANDER · ARCHITECT
BOARD · OF · EDUCATION
CHICAGO

FIG. 79.

The Assembly Hall. — The assembly hall is no longer a place to be closed up all of the year except upon the last day of each term. The assembly hall should be used by the school for all sorts of school work and recreation. It should be available for a great variety of community interests and it should become a real asset to the school in bringing the school and the community closer together. It is important therefore that the assembly room be so located as to be easily accessible to those portions of the school using it most, and at the same time so located that it can be used by the community without interfering with the rest of the school building.

Office and Library. — Economy of space may be well practiced in the arrangement of office and library and yet provide a perfectly satisfactory equipment. In elementary buildings, of which we are now speaking, there should be a small ante-room and adjacent to it a small office. These rooms sometimes have been omitted altogether, and in other cases they have been made excessively large. Both mistakes should be avoided. Adjacent to the office should be a storeroom for school supplies, and another room which may be called the library but which is primarily a storeroom for books. The reading of the books should be under the supervision of the classroom teachers in the classrooms.

There should be located conveniently in every classroom as a part of the building a suitable bookcase and filing cabinet. This can be arranged as one piece with bookshelves above and the file space for school papers below.

The Elementary Course of Study. — In high schools and junior high schools a proper plan of the building is dependent upon a knowledge of the course of study to be pursued therein. In a very much less degree is this true in the elementary schools, but even there it is necessary for those who are planning such buildings to know something of the nature of the activities to be conducted. Kindergarten rooms have become fairly well standardized because the kindergarten itself is standardized, perhaps too much so.

In the lowest primary grades through three or four years work the classroom work is very largely confined to acquiring the tools of learning. There should be abundant blackboard space — all that it is possible to secure. In addition to the regular standard desks there should be room for carrying on some schoolroom activities. Just what these shall be no one is able to say. Perhaps it is well that this is true. It is generally conceded that there should be opportunity for these grades to work around sand tables or around a table on which they portray by their own handiwork

various types of human activities. In the grades above the fourth and even including the fourth, in addition to the studies long established in the schools — reading, writing, arithmetic, and spelling — every modern school will have adequate provision for history, geography, nature study, physical education, music, drawing, and various types of handwork. The history and geography need the assistance of the stereopticon, projectoscope, and moving picture apparatus. The geography and nature study can be better conducted with the assistance of an experimental or science room. Physical education demands proper playgrounds, indoor playgrounds for inclement weather, showers, and perhaps a swimming pool, and can well use the auditorium for some activities. The needs for music, drawing, and handwork have been spoken of elsewhere. Therefore, in conclusion it is most urgently recommended that before attempting to actually record by drawings the rooms and departments of the school so as to formulate a scheme for any such building, the architect and the schoolman should study fully the requirements of each school problem. The present and near future enrollment, the prospect of the community changing in character — that is, from residential to industrial, the possibilities of changes in methods of teaching, the important phases of child hygiene, these with many other features pertaining to school administration and the health and well being of the child are problems that should be thoroughly thrashed out in conferences before the preliminary drawings are started.

The tabulations given in Chapter IV under the Requirements for Low Elementary and High Elementary Schools will be aids in determining the physical needs. From these tabulations may be prepared more extensive building programs than are outlined therein, for certain communities have problems differing from those of others, and it is a recognized fact that schools like individuals cannot be of the same mould. If the planning of the school is viewed from this standpoint a good start will have been made, and from there on the success of the work will depend largely upon the growth of this early vision and upon familiarity with the phases and aspects of the building to house and care for the child in its preparation for life's work.

The writer hesitates to trespass upon premises of other's provinces, but it does seem that the architecture of the elementary school should be symbolic of quiet simplicity, expressing in permanent materials much the same charm that the little child has for those who appreciate and love children. Vainglorious attempts to build monumentally are fatal to both child and adult, for instead of attracting the child's interest they are most likely to repel and make fearful. First impressions are most lasting and most influential and how much better it is if the impressions and influences of the architecture are pleasing and beneficial at an early age.

Mr. John J. Donovan, Architect.

FIG. 80. — LELAND STANFORD JR. UNIVERSITY ELEMENTARY SCHOOL, PALO ALTO, CALIFORNIA.

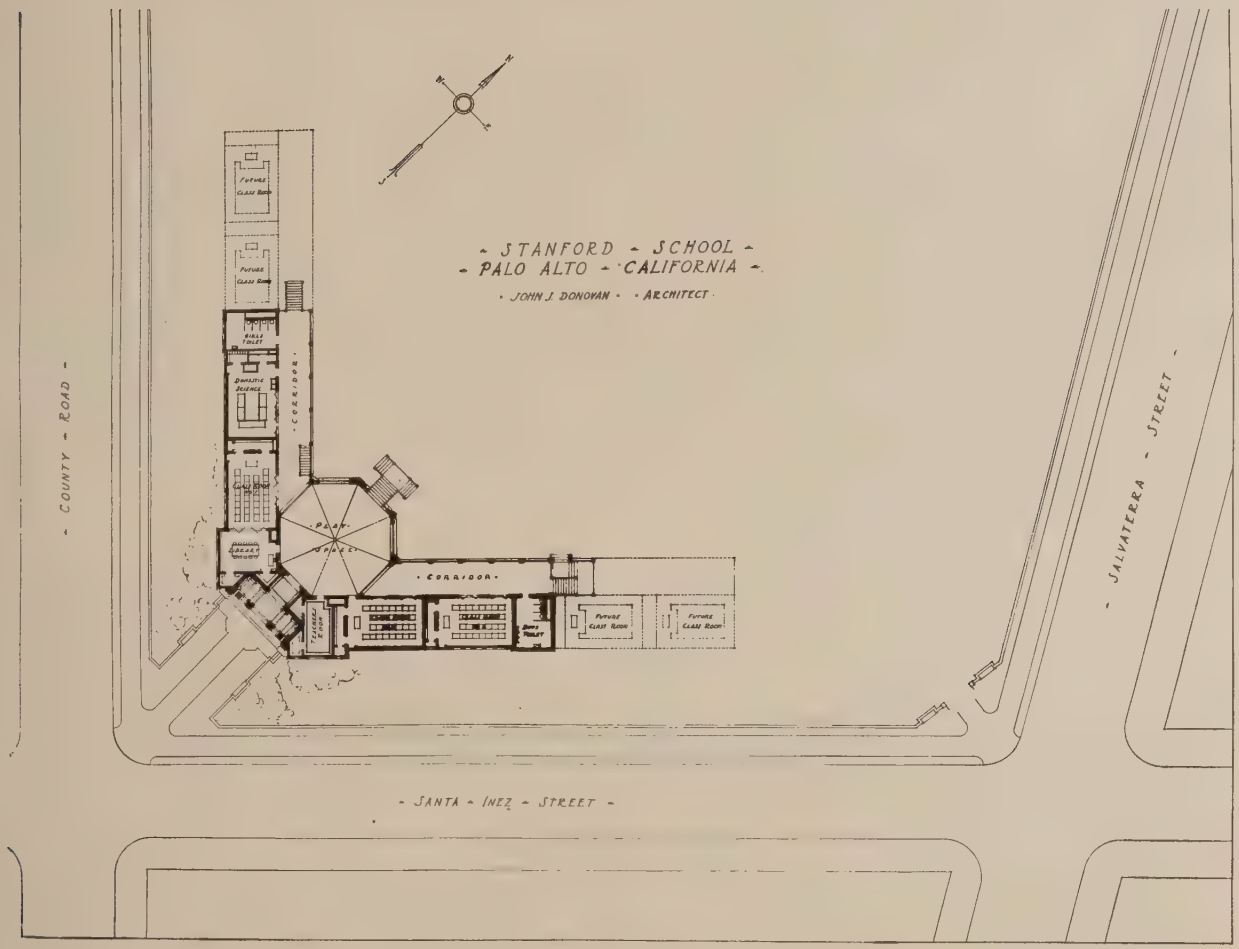

STANFORD SCHOOL
PALO ALTO CALIFORNIA
JOHN J. DONOVAN ARCHITECT
COUNTY ROAD
SALVATIERRA STREET
SANTA INEZ STREET
CORRIDOR
FUTURE CLASS ROOM
FUTURE CLASS ROOM
BOYS' TOILET
GIRLS' TOILET
DOMESTIC SCIENCE
BIBLE CLASS ROOM
FUTURE CLASS ROOM
FUTURE CLASS ROOM

FIG. 81.

Mr. John J. Donovan, Architect.

FIG. 82. — LELAND STANFORD JR. UNIVERSITY ELEMENTARY SCHOOL, PALO ALTO, CALIFORNIA.

Mr. John J. Donovan, Architect.

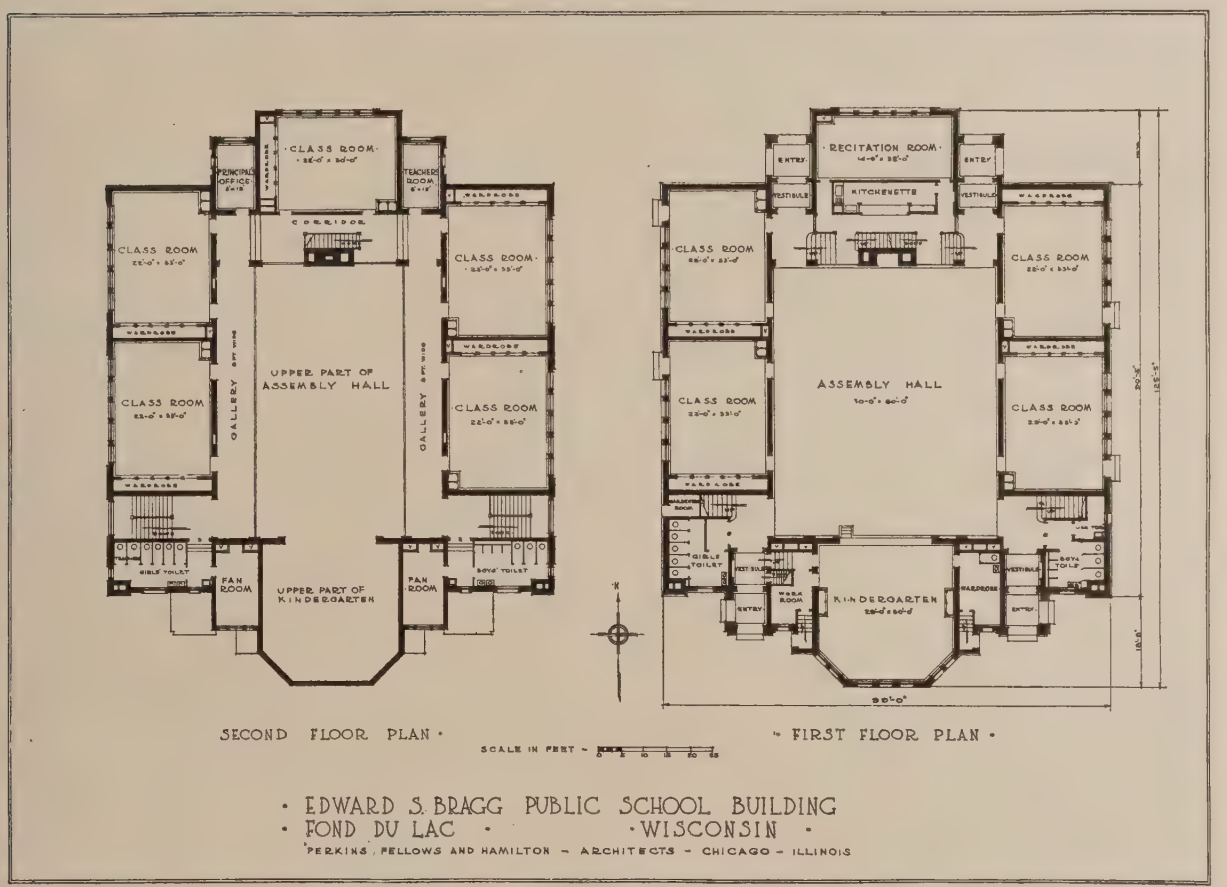
FIG. 83. — LELAND STANFORD JR. UNIVERSITY ELEMENTARY SCHOOL, PALO ALTO, CALIFORNIA.

Mr. John J. Donovan, Architect.

FIG. 84. — LELAND STANFORD JR. UNIVERSITY ELEMENTARY SCHOOL, PALO ALTO, CALIFORNIA.

Messrs. Perkins, Fellows and Hamilton, Architects.

FIG. 85. — EDWARD S. BRAGG SCHOOL, FOND DU LAC, WISCONSIN.



EDWARD S. BRAGG PUBLIC SCHOOL BUILDING
FOND DU LAC · WISCONSIN
PERKINS, FELLOWS AND HAMILTON — ARCHITECTS — CHICAGO — ILLINOIS

FIG. 86.

BIRMINGHAM REFERENCE LIBRARY

Messrs. Perkins, Fellows and Hamilton, Architects.

FIG. 87. — OAKTON SCHOOL DISTRICT 76, EVANSTON, ILLINOIS.

Messrs. Perkins, Fellows and Hamilton, Architects.

FIG. 88. — OAKTON SCHOOL DISTRICT 76, EVANSTON, ILLINOIS.

Mr. Wm. B. Ittner, Architect.

FIG. 89. — GLASGOW SCHOOL, ST. LOUIS, MISSOURI.

Mr. Wm. B. Ittner, Architect.

FIG. 90. — ASHLAND SCHOOL, ST. LOUIS, MISSOURI.

Mr. Wm. B. Ittner, Architect.

FIG. 91. — GRAMMAR SCHOOL, KIRKWOOD, MISSOURI.

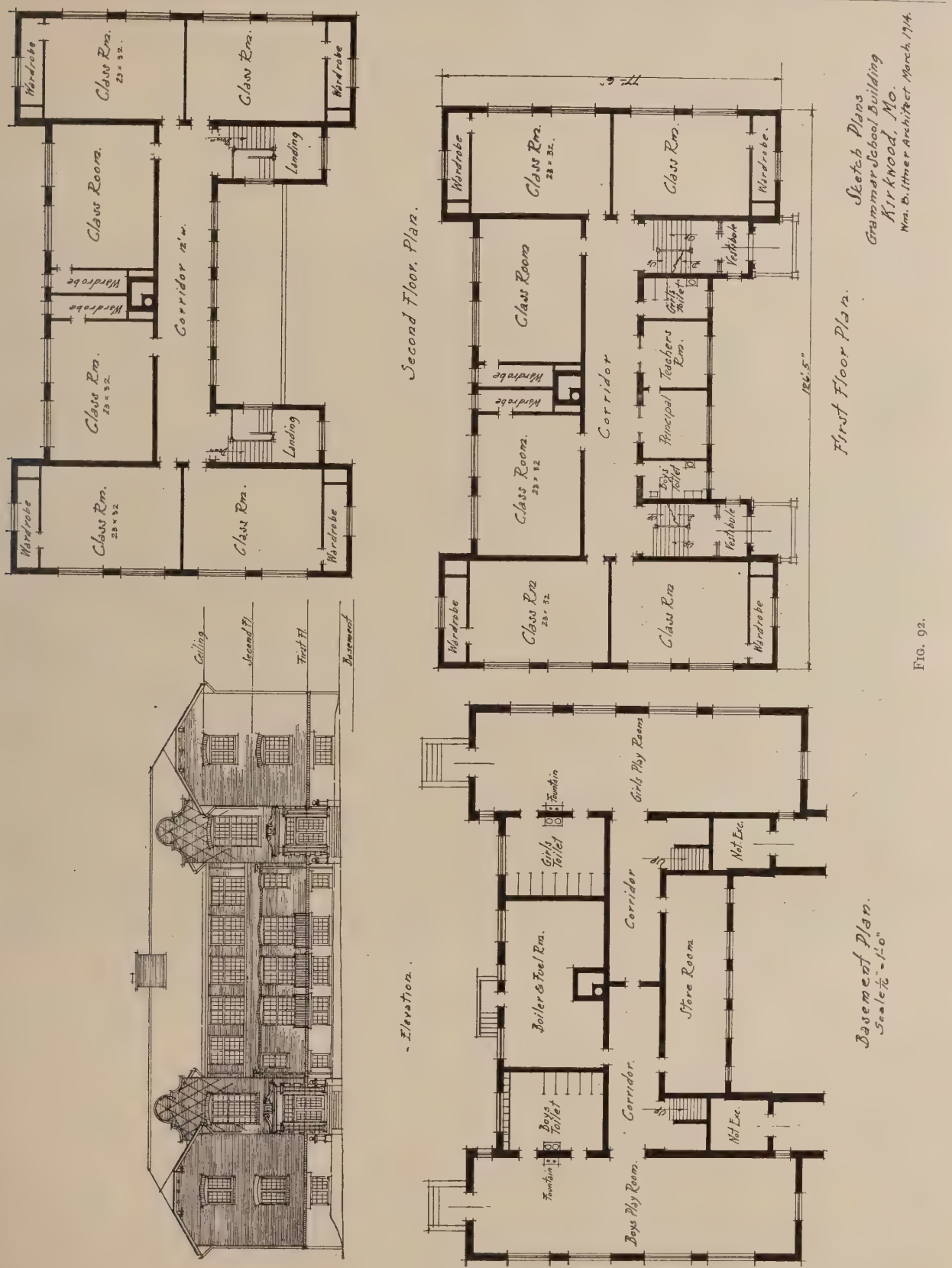

Sketch Plans
Grammar School Building
Kirkwood, Mo.
Wm. B. Ittner Architect March, 1914.
Second Floor Plan.
First Floor Plan.
Basement Plan.
Scale 1/8" - 1'-0"
Elevation.
Class Rm.
Class Room.
Corridor
Wardrobe
Landing
Girls Toilet
Boys Toilet
Principal
Teachers Rm.
Vestibule
Boiler & Fuel Rm.
Store Room
Girls Play Room
Boys Play Room
Fountain
Ceiling
Second Fl.
First Fl.
Basement

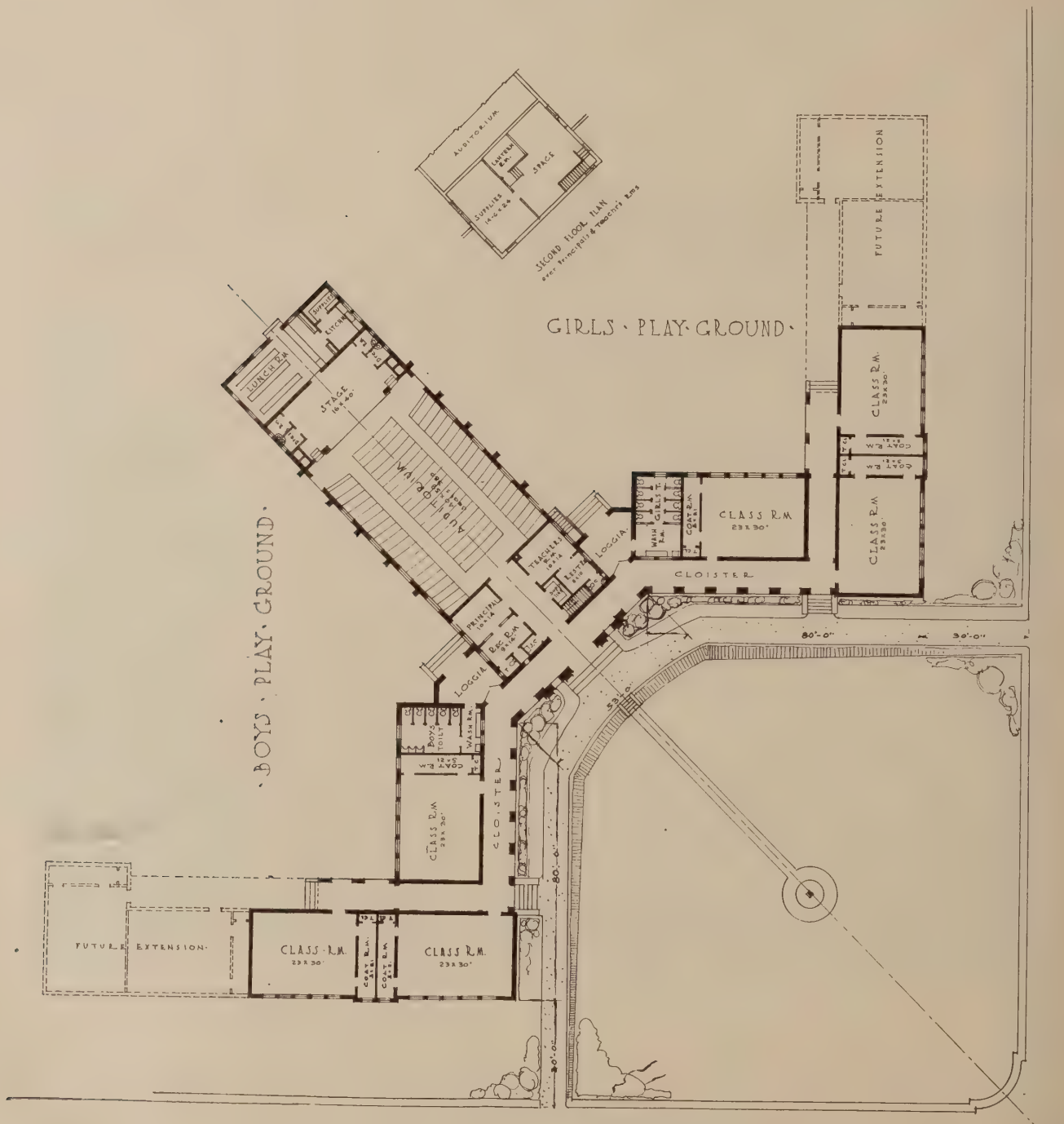
Fig. 92.

Allison and Allison, Architects.

FIG. 93. — GRAMMAR SCHOOL NO. 2, GLENDORA, CALIFORNIA.

Allison and Allison, Architects.

FIG. 94. — GRAMMAR SCHOOL NO. 2, GLENDORA, CALIFORNIA.



GRAMMAR SCHOOL No 2 GLENDORA CAL
ALLISON & ALLISON ARCHITECTS L.A.CAL.

FIG. 95

CHAPTER VI

THE ORGANIZATION OF THE INTERMEDIATE OR JUNIOR HIGH SCHOOL AS AFFECTING BUILDINGS

By E. Morris Cox, A.B., *Assistant Superintendent of Schools, Oakland, California*

The Types of Junior High School. The Academic Type. The Industrial Type. The Neighborhood or Community Type. The Cosmopolitan Type. Science Laboratories. Library. Office Equipment. Teachers' Retirement and Lunch Rooms. The Auditorium and Gymnasium. The Junior High School Course of Study.

In a very large measure the conditions outlined in reference to the elementary schools apply likewise to the junior high school. It is therefore suggested that the preceding chapter in relation to the elementary schools should be read before this chapter. It is possible that the school site may need to be larger than for elementary schools to supply sufficient room for school gardening, athletic fields, etc. In the main, however, the recommendations in the former chapter regarding the general arrangement of the building, its cleanliness, and the completeness of its equipment, may be applied to this type of school. Whether there should be a third story in a junior high school may be a matter of sufficient difference of opinion as to leave the final answer dependent upon conditions to be met in individual cases.

The Types of Junior High School. — The character of the building should depend largely upon the particular type of school for which the structure is being planned. There have already been developed in various communities four rather distinct types of junior high schools, — the academic, the industrial, the cosmopolitan, and the neighborhood or community school.

The Academic Type. — This type of building is much better standardized than any of the others. The building should consist of standardized classrooms, with some laboratory equipment, some simple shops, suitable music and drawing laboratories and about the same type of office equipment, library, and auditorium accommodations as would be used in the other types.

The Industrial Type. — Probably any discussion as to the exact equipment and accommodation for an industrial type junior high school would be out of date before it could be printed and circulated. Such rapid changes and improvements have been taking place that almost every building erected contains important new features. Really nothing in the way of shop accommodations has been standardized. It is, however, generally considered that schools of this type should provide for sheet metal work, woodworking, machine shop practice, blacksmithing, printing, and a variety of types of classes in general sewing, millinery, dressmaking, cooking, and dietetics. One general criticism may be passed on most of the buildings of this type. Proper attention has not been given to storage space for raw materials or for the partially completed or completed work. At present there is a general consensus of opinion that the drawing to be done in connection with the industrial work should be under the supervision of a drawing department working in close harmony with the shops and laboratories. If this becomes an established procedure, the drawing laboratories should be more completely developed than has previously been the case.

The Neighborhood or Community Type. — This type of school differs from the others in its equipment for general community service. Such a school partakes largely of the nature of the industrial school. The shops can be so planned as to offer opportunities for afternoon and evening work for the men, and the laboratories, cooking, sewing, millinery, and dressmaking rooms may be as well adapted to the use of the women of the neighborhood as for the pupils of the day school. Some of these activities may be better carried on in a community cottage separate and apart from these classrooms, in which can be organized a great variety of community activities and in which the Americanization work for the mothers of the community may be largely carried on. The community type of school must needs carry both its indoor and outdoor recreational and physical training facilities to all of the people of the neighborhood. The library and laboratories should be as thoughtfully planned for general community use as

Fig. 96. — Junior High School, Trenton, New Jersey.

they are for day school use, and the auditorium can be used even more for community use than for the regular day school.

The Cosmopolitan Type. — In many neighborhoods, the variety of needs will be so great as to make it necessary that the building be constructed as far as possible to meet the variety of conditions outlined under each of these types. It may not be possible to develop each line as fully as in the special types, but through a careful selection, various types of work along the several lines may be included.

Science Laboratories. — The general deficiency in scientific training given by our lower schools is becoming recognized. Lack of experience in proper science teaching in these schools has limited the data at hand from which to determine how many or what type of science laboratories should be installed in a junior high school, or to what extent these laboratories should be equipped with scientific apparatus and appliances. Pupils and schools of this type are just at the age when they should receive their introduction to scientific thought. It would therefore seem that the science courses in schools of this type should be of a somewhat general nature. If this is correct, there should be laboratories enough to give to all pupils in the school an opportunity for science training amounting to at least two recitation periods per week. These laboratories should be equipped with working tables, with gas, electricity, and running water, and with a rather liberal equipment for keeping living plants and animals and other specimens in the laboratory.

Library. — There should be a library room in charge of a librarian. The library should be liberally equipped with books carefully selected on the basis of their direct application to the work of the school. Pupils should be carefully taught the use of reference books and the use of a library for topical study. This means, therefore, that the libraries should be of liberal size and planned as if to be directed by a regular librarian.

FIG. 97. — JUNIOR HIGH SCHOOL, TRENTON, NEW JERSEY.

Office Equipment. — A proper arrangement of offices with the necessary equipment for the administrative work of the school frequently receives too little attention. There should be an outer and an inner office with a liberal-sized storeroom for school supplies adjacent. A master clock, controlling the program and secondary clocks and bells of the school, should be installed in the office and likewise a serviceable telephone system connecting with all the rooms of the building. The outer office should be so arranged as to provide working and filing space for the principal's clerk. In the large schools there should be an office for a vice principal. In case this official is a woman, the office may advantageously be located adjacent to and connected with the rest rooms for women teachers.

Teachers' Retiring and Lunch Rooms. — Adequate, comfortable, and attractive rooms for the use of the teachers will repay the community many fold. Too often these rooms do not exist at all or are arranged in some little nook because it is of no service for any other purpose. The nature of teaching is such that under the very best of conditions the tax upon the physical well-being of teachers is sufficient to exhaust even the hardiest. Consequently everything that is done in the school building arrangements to protect this physical well-being will return dividends to the school.

The Auditorium and Gymnasium. — It is a difficult thing to plan an auditorium to serve all of the activities that should be carried on in the community meeting room connected with the school building. The problem is very much simplified if a gymnasium separate from the auditorium is possible. In this case the gymnasium should be so planned as to provide for a great variety of indoor athletic activities and of course should have adjacent to it lockers, showers, and lavatories. The auditorium should have a seating capacity for all of the school if possible, and should be equipped for both school and community use with a moving picture

FIG. 98. — JUNIOR HIGH SCHOOL, TRENTON, NEW JERSEY. *Mr. Wm. A. Poland, Architect.*

apparatus. The chairs should be movable so that the floor may be used for a variety of other purposes, — receptions, exhibitions of school work, and other activities.

The Junior High School Course of Study. — These institutions are so new, that the course of study has not become thoroughly standardized. It seems, however, that a course of study something like the following will offer a standard for building plans.

First Year (7th year of schooling)

English: reading, spelling, language study, penmanship.
History and geography
Arithmetic
Science
Music, vocal and instrumental
Drawing
Physical training and hygiene
Industrial and vocational subjects
Foreign languages
Commercial subjects (stenography and typing)

Second Year (8th-year of schooling)

Course similar to first year with probably some variations in hours.

Third Year (9th year of schooling)

English, including grammar and composition
Science
(At least three electives for each pupil from the following subjects)
Foreign languages
Mathematics
History
Industrial and vocational subjects
Commercial subjects
Music, vocal and instrumental
Drawing

The amount of work offered in industrial and vocational subjects, foreign languages, commercial subjects, music, and drawing would depend upon the type of school.

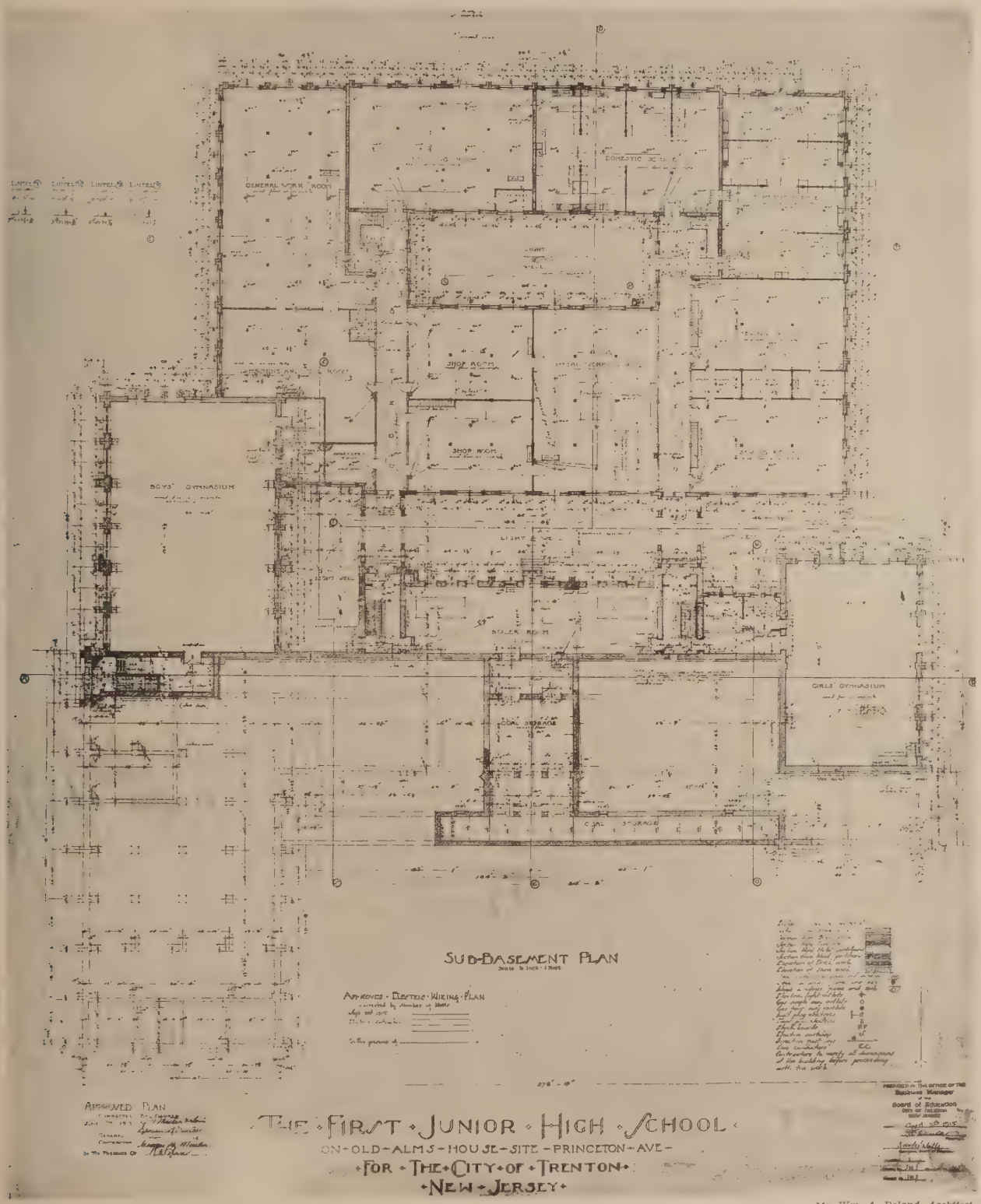

GENERAL WORK ROOM
DOMESTIC SCIENCE
SHOP ROOM
METAL WORK
SHOP ROOM
BOYS' GYMNASIUM
LIGHT WELL
STAGE
GIRLS' GYMNASIUM
COAL STORAGE
COAL STORAGE
SUB-BASEMENT PLAN
APPROVED · ELECTRIC · WIRING · PLAN
APPROVED PLAN
THE · FIRST · JUNIOR · HIGH · SCHOOL ·
ON · OLD · ALMS · HOUSE · SITE · PRINCETON · AVE ·
· FOR · THE · CITY · OF · TRENTON ·
· NEW · JERSEY ·

FIG. 99.

Mr. Wm. A. Poland, Architect.

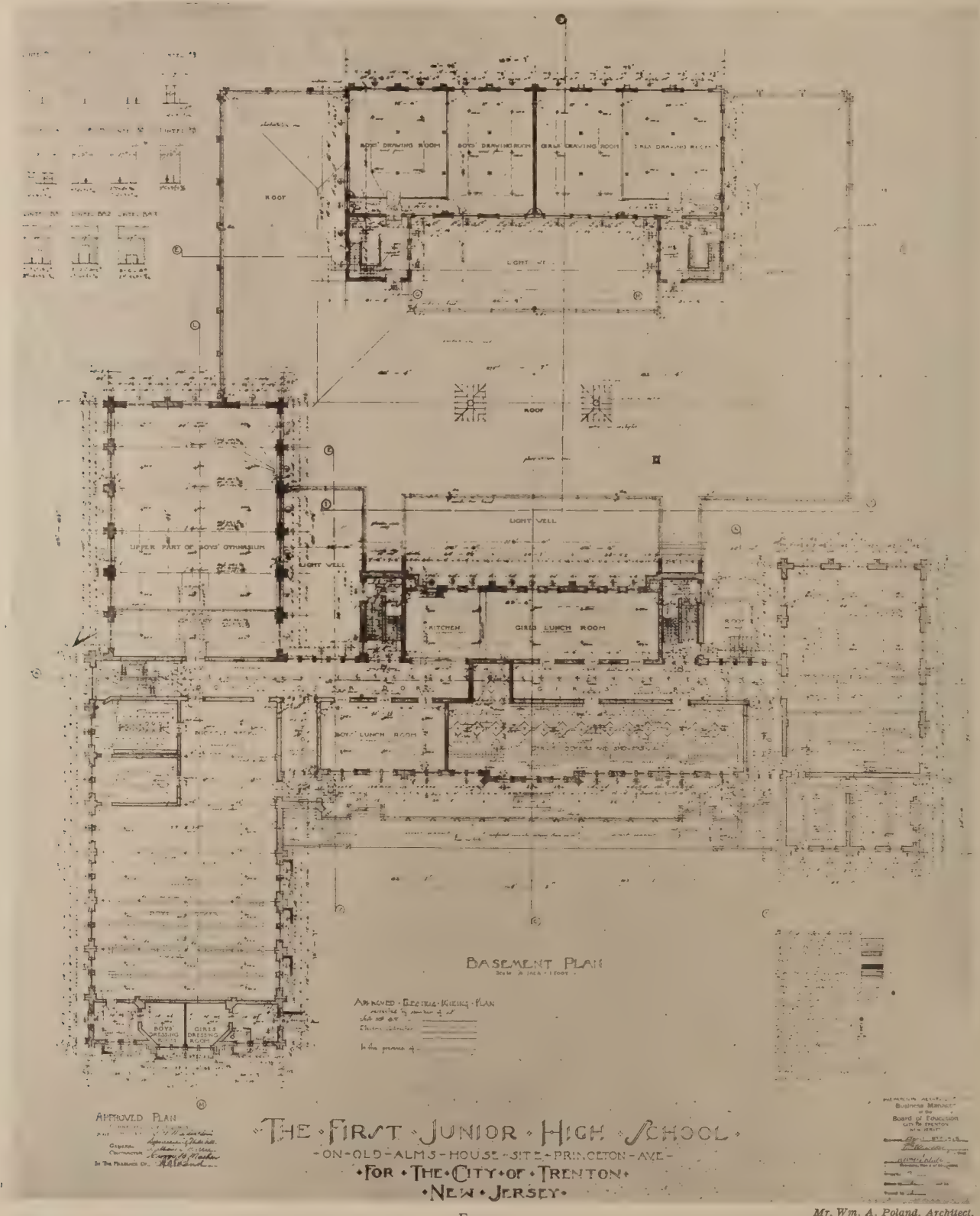


FIG. 100.

Mr. Wm. A. Poland, Architect.

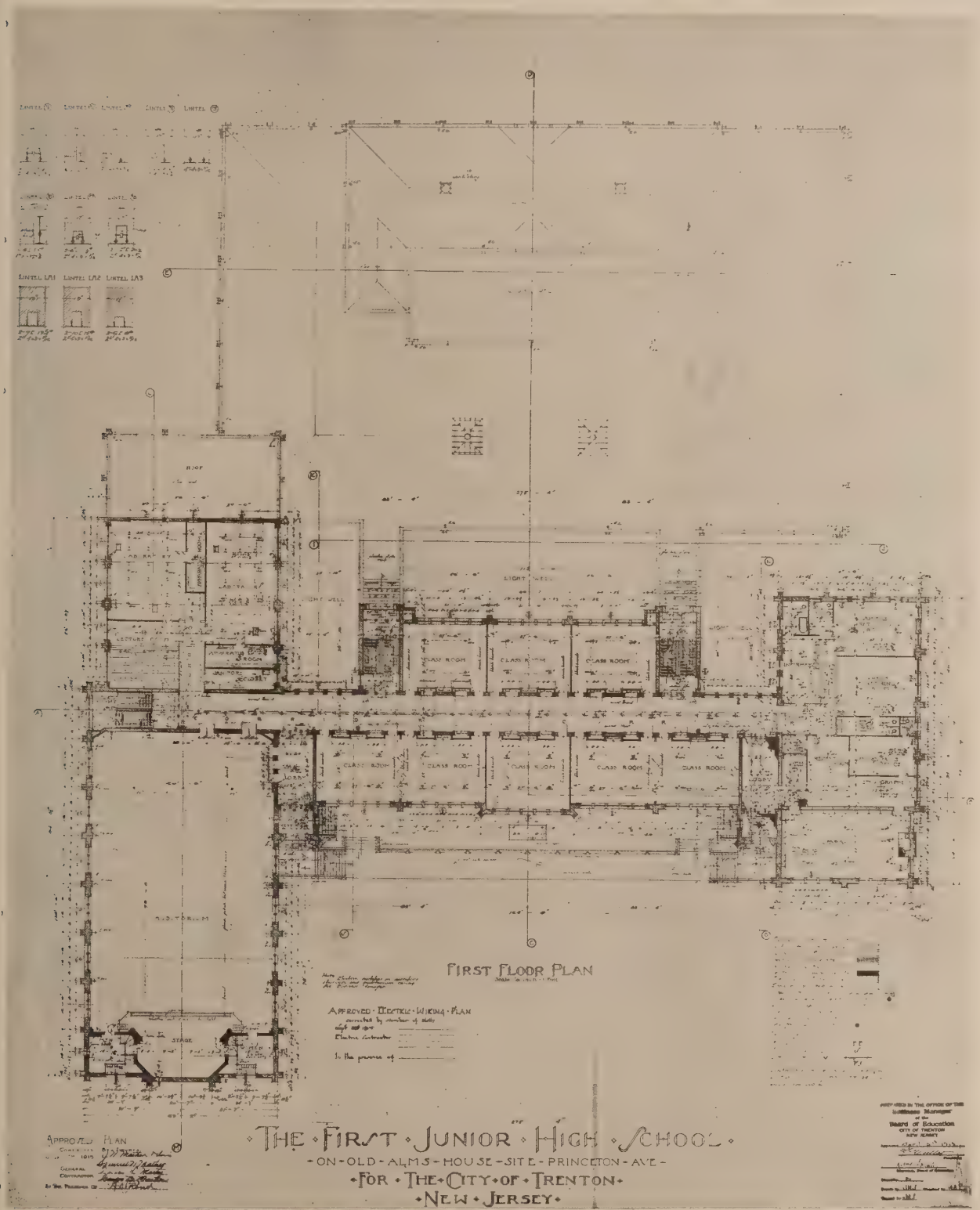


FIG. 101.

Mr. Wm. A. Poland, Architect.

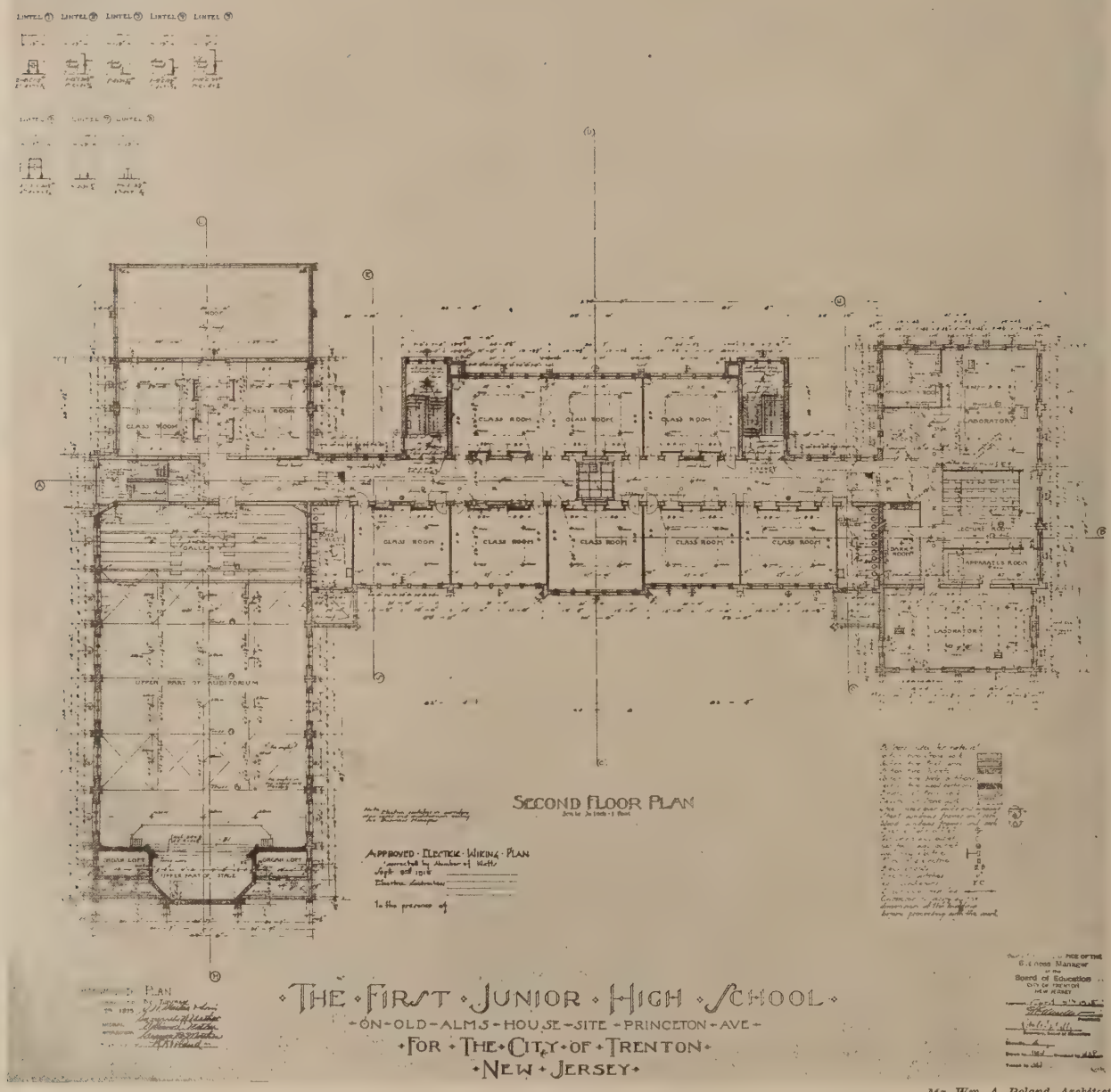

SECOND FLOOR PLAN
APPROVED · ELECTRIC · WIRING · PLAN
THE · FIRST · JUNIOR · HIGH · SCHOOL
ON · OLD · ALMS · HOUSE · SITE · PRINCETON · AVE ·
FOR · THE · CITY · OF · TRENTON ·
NEW · JERSEY ·

FIG. 102

MT. WM. A. POLAND, ARCHITECT.

Mr. Theo. M. Sanders, Architect.

FIG. 103. — JUNIOR HIGH SCHOOL, LITTLE ROCK, ARKANSAS.

Mr. Theo. M. Sanders, Architect.

FIG. 104. — JUNIOR HIGH SCHOOL, LITTLE ROCK, ARKANSAS.

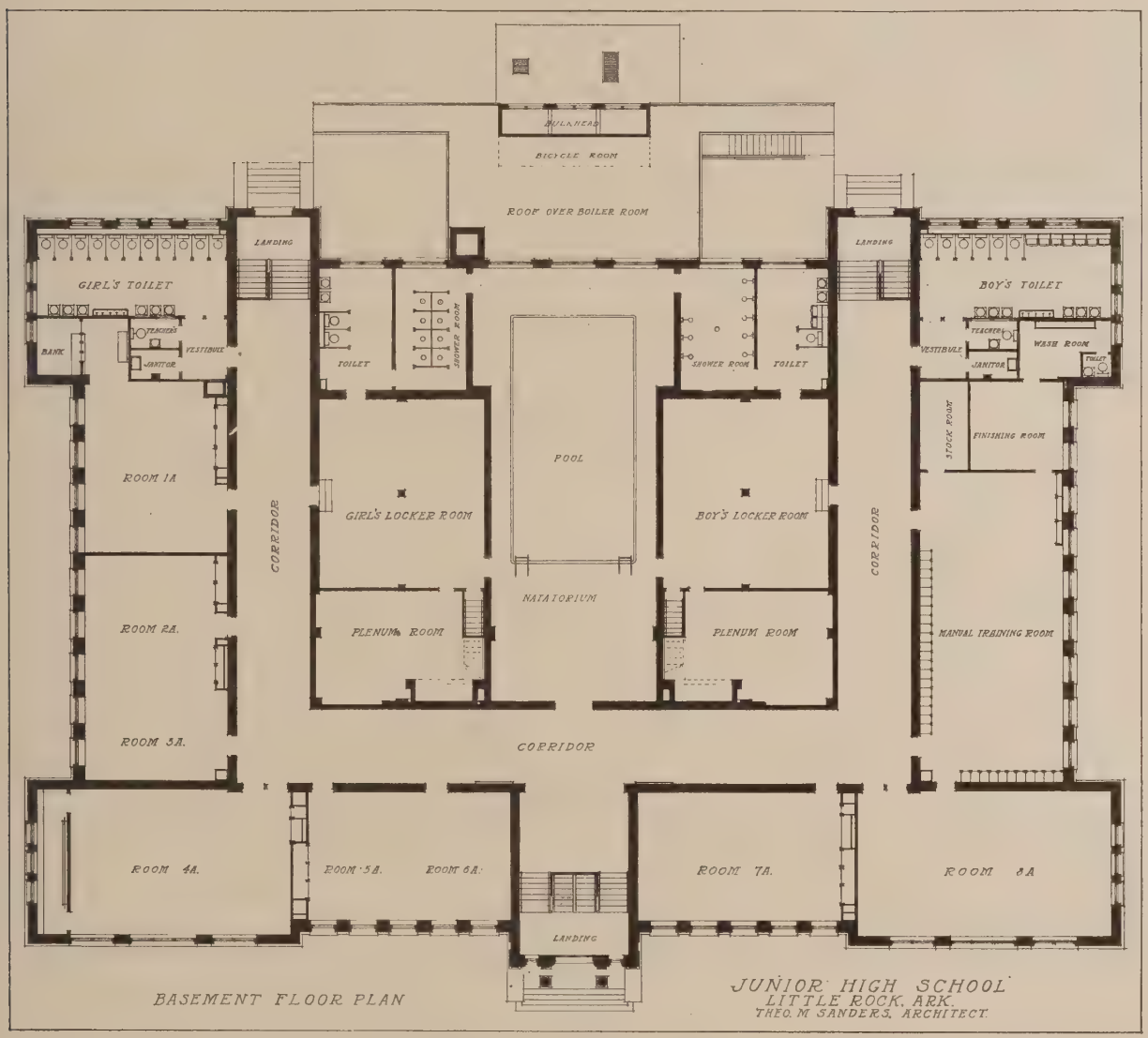
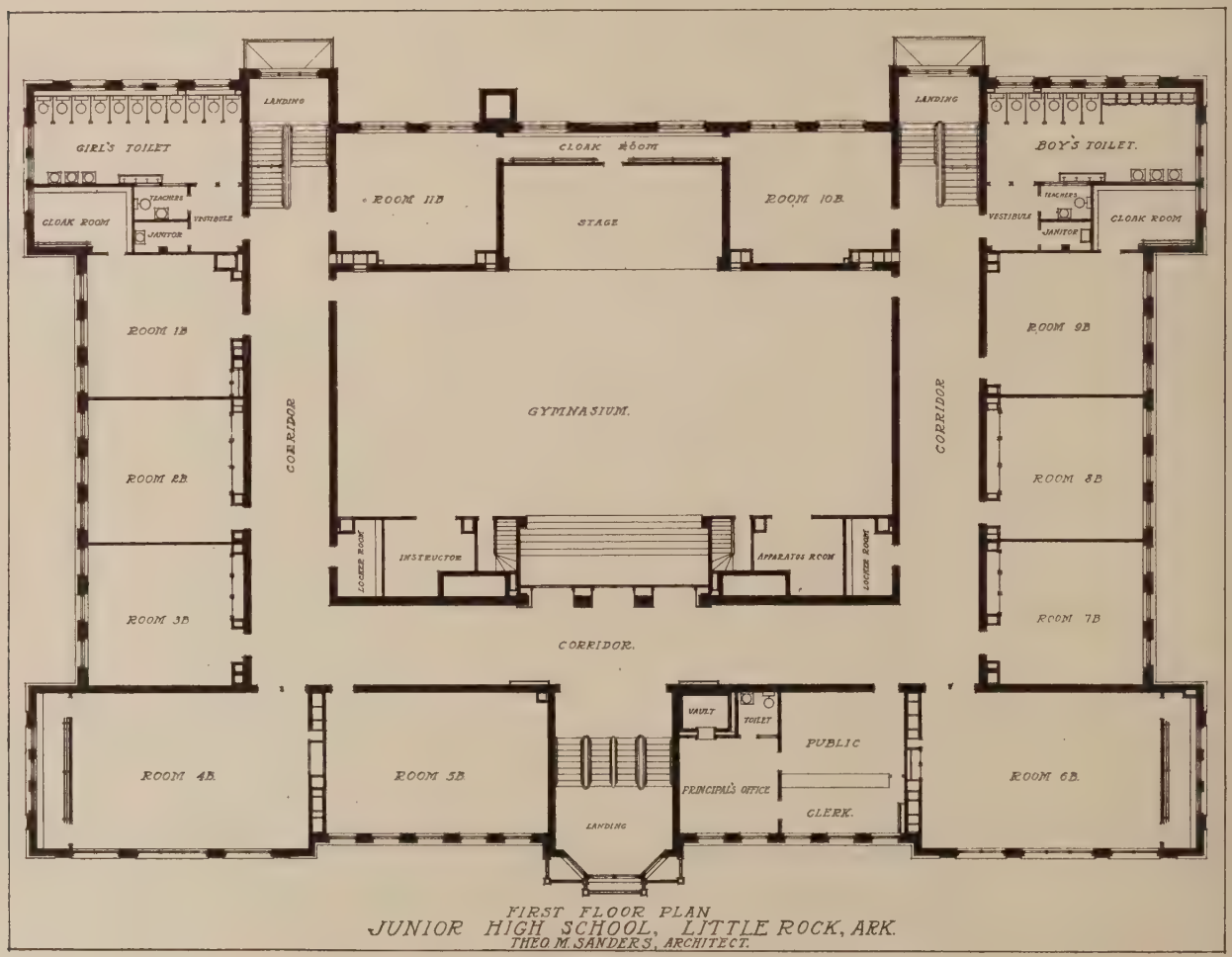

BULKHEAD
BICYCLE ROOM
ROOF OVER BOILER ROOM
LANDING
LANDING
GIRL'S TOILET
BOY'S TOILET
BANK
TEACHER
VESTIBULE
JANITOR
TOILET
SHOWER ROOM
SHOWER ROOM
TOILET
TEACHER
VESTIBULE
JANITOR
WASH ROOM
TOILET
STOCK ROOM
FINISHING ROOM
ROOM 1A
CORRIDOR
GIRL'S LOCKER ROOM
POOL
BOY'S LOCKER ROOM
CORRIDOR
NATATORIUM
ROOM 2A.
PLENUM ROOM
PLENUM ROOM
MANUAL TRAINING ROOM
ROOM 3A.
CORRIDOR
ROOM 4A.
ROOM 5A.
ROOM 6A.
ROOM 7A.
ROOM 8A
LANDING
BASEMENT FLOOR PLAN
JUNIOR HIGH SCHOOL
LITTLE ROCK, ARK.
THEO. M. SANDERS, ARCHITECT.

FIG. 105.



FIRST FLOOR PLAN
JUNIOR HIGH SCHOOL, LITTLE ROCK, ARK.
THEO. M. SANDERS, ARCHITECT.

FIG. 106.

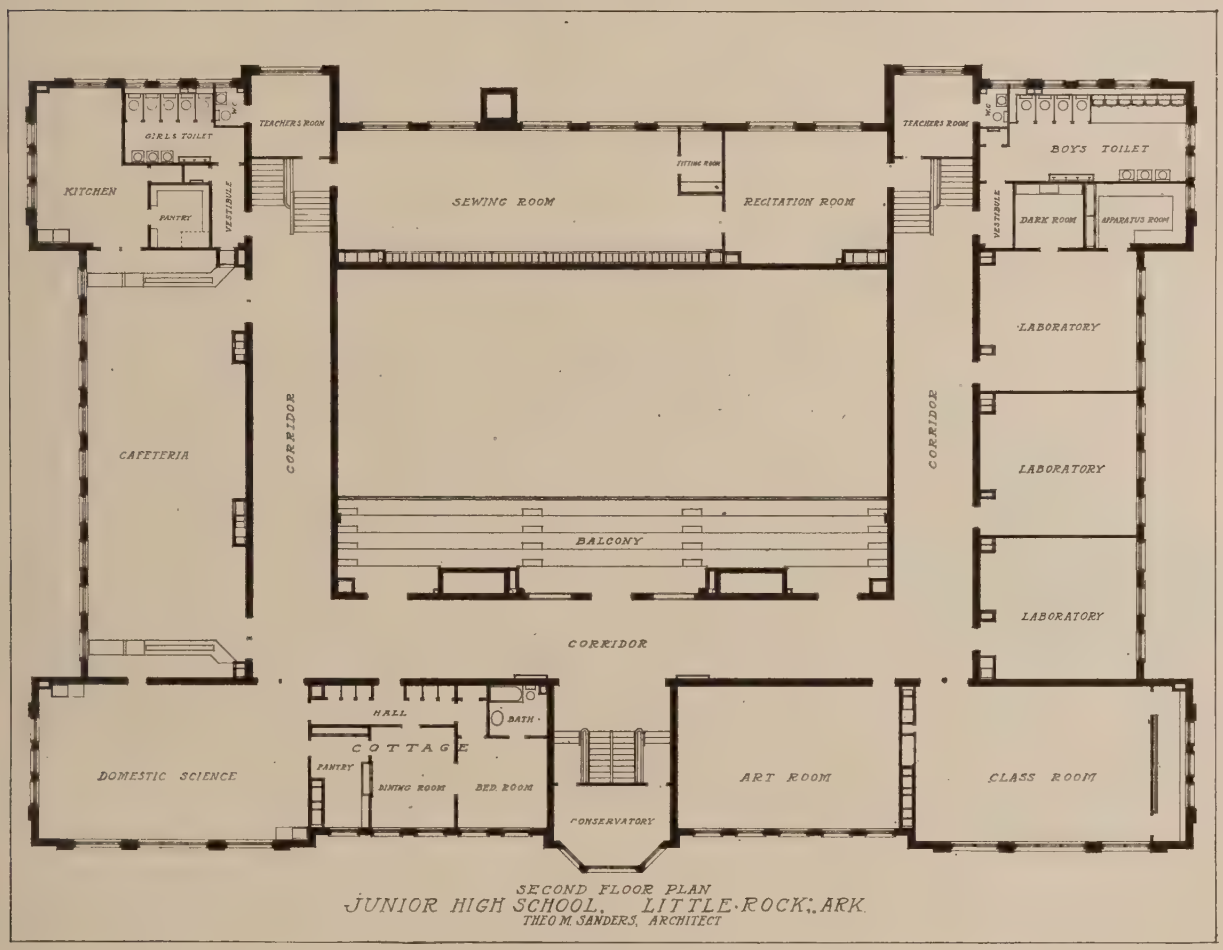

GIRL'S TOILET
TEACHER'S ROOM
KITCHEN
PANTRY
VESTIBULE
SEWING ROOM
FITTING ROOM
RECITATION ROOM
TEACHER'S ROOM
W.C.
BOY'S TOILET
VESTIBULE
DARK ROOM
APPARATUS ROOM
LABORATORY
LABORATORY
LABORATORY
CAFETERIA
CORRIDOR
CORRIDOR
BALCONY
CORRIDOR
HALL
BATH
COTTAGE
PANTRY
DINING ROOM
BED ROOM
DOMESTIC SCIENCE
CONSERVATORY
ART ROOM
CLASS ROOM
SECOND FLOOR PLAN
JUNIOR HIGH SCHOOL, LITTLE ROCK, ARK.
THEO M. SANDERS, ARCHITECT

FIG. 107.

FIG. 108. — EDISON JUNIOR HIGH SCHOOL, BERKELEY, CALIFORNIA.

Mr. W. H. Ratcliff, Jr., Architect.

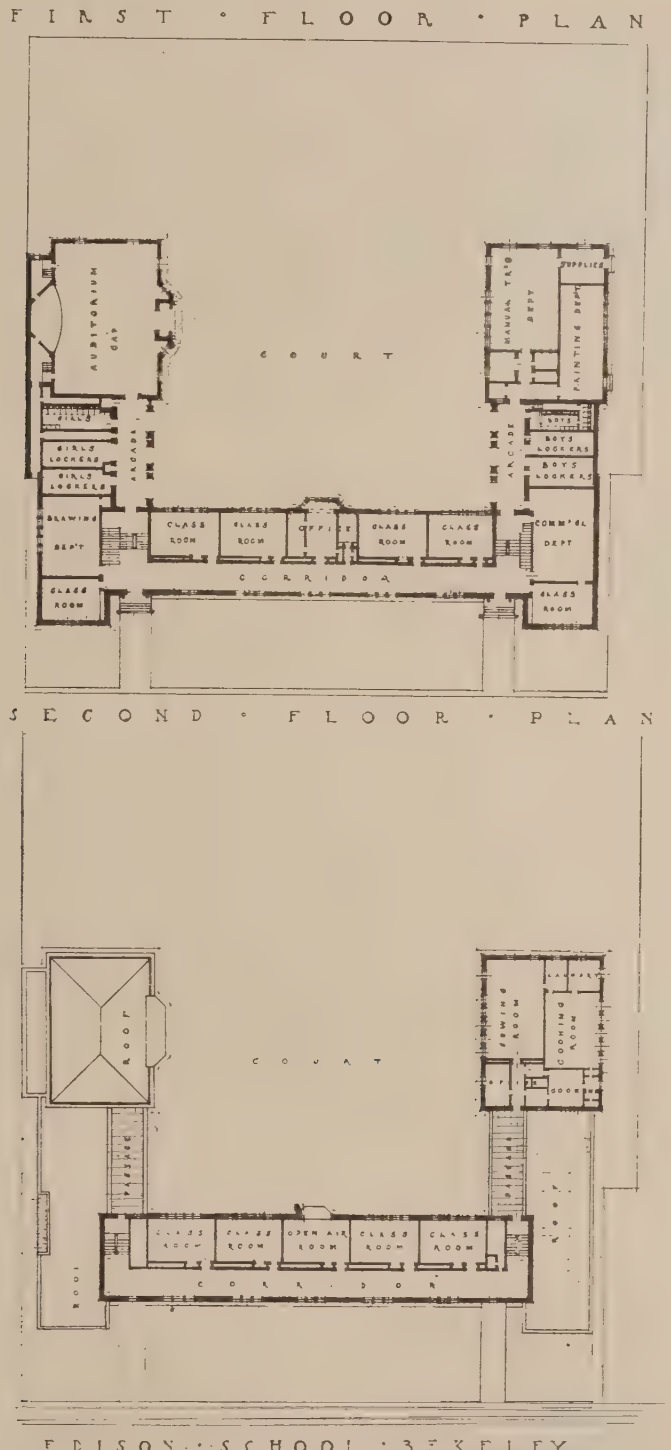

FIRST · FLOOR · PLAN
AUDITORIUM
COURT
MANUAL TRG DEPT
SUPPLIES
PAINTING DEPT
GIRLS LOCKERS
BOYS LOCKERS
ARCADE
DRAWING DEPT
CLASS ROOM
OFFICE
COMM'L DEPT
CORRIDOR
SECOND · FLOOR · PLAN
ROOF
COURT
SEWING ROOM
COOKING ROOM
OPEN AIR ROOM
CORRIDOR
EDISON · SCHOOL · BERKELEY
A·W·SNRATCLIFF·JR·ARCHITECT

FIG. 109.

CHAPTER VII

ORGANIZATION AND ADMINISTRATION OF SENIOR HIGH SCHOOLS AS AFFECTING BUILDINGS

By Clarence D. Kingsley (M.A. Columbia University), *Supervisor of High Schools, Massachusetts Department of Education*[1]

I. Who Are to be Served: 1. Organization of the School System; 2. Variations in the Three-Block System; 3. Comprehensive versus Special-Type High Schools; 4. Determination of the Contributing Area for Senior High Schools; 5. Determination of the Contributing Area for Junior High Schools; 6. Probable Number of Pupils to be Furnished by the Contributing Area.

II. Internal Organization as Affecting Accommodations: 1. Flexibility; 2. Program of Studies; 3. Staff of the School; 4. Size of Laboratories and Shops; 5. Size of Classrooms; 6. Actual Size of Classes; 7. Provisions for Study; (*a*) Kind of Provisions to be Made; (*b*) Number of Sittings Required; (*c*) Size of Study Halls; (*d*) Articulation of Study Halls with the Library; 8. Time-Allotment for Physical Training; 9. Number of Periods in the School Day; (*a*) Length of Period; (*b*) Length of School Day.

III. Estimate and Tabulation of Accommodations Needed: 1. Multiple Uses; (*a*) Laboratory-Recitation Rooms; (*b*) Gymnasium-Assembly Hall; 2. Sample Tabulation for a School of about 200 Pupils; 3. Sample Tabulation for a School of about 400 Pupils.

Appendix. A Schedule Providing for the Limited Introduction of Supervised Study. Special Provisions for Pupils Who Must Work Afternoons and Evenings.

I. Who Are to be Served. — Before determining the site, costs, or sketch plans for a high school building, a thorough and comprehensive study should be made to ascertain the most desirable organization of the school system, the type of high school needed, the contributing area, and the probable number of high school pupils that will be furnished by the contributing area.

1. *Organization of the School System.* — The authors of this book have assumed that the school system will contain elementary, junior high, and senior high schools. In view, however, of the fact that the introduction of junior high schools is a recent innovation, and the further fact that many cities have not as yet adopted the junior high school idea, a brief statement of the reasons favoring the new organization may be helpful.

A system in which eight years are devoted to elementary education and four years to secondary education is conveniently designated as an 8–4 system. One in which elementary education is shortened to six years, followed by three years for junior high schools and three for senior high schools, is known as a 6–3–3 system.

The chief reasons for changing from an 8–4 to a 6–3–3 system may be summarized as follows:

(*a*) The seventh and eighth years of the elementary school have not, on the whole, been effectively utilized. Too much time has been devoted to reviewing material previously taught in the first six years. The work has lacked interest and many pupils have felt that they were gaining but little. In fact, fully one-half of the pupils have, in many communities, left school in these years. The pupils who remained commonly developed habits of dawdling at their work. These habits, bad in themselves, have been a serious detriment to high school work. Proficiency in certain fundamental processes may be better secured by the application of these processes to new subjects in the junior high school than by these reviews in elementary subjects.

(*b*) The first year of the four-year high school has not been well adapted to the needs of the pupils of that year. The break from the school organization, subjects of study, and methods of instruction in the elementary school to the organization, subjects, and methods in the high school has been too sudden. The pupils have not been prepared for the transition. As a result the number of pupils leaving school in the first year of the four-year high school has been abnormally large. The junior high school is succeeding in bridging this gap. It makes possible the gradual introduction of departmental instruction, so that the pupil may pass from the constant and personal supervision by one teacher to instruction by four or more teachers.

(*c*) The junior high school provides a social organization which develops self-expression, qualities of initiative and coöperation, and a sense of personal responsibility.

[1] Mr. Kingsley is chairman of the Commission on the Reorganization of Secondary Education, appointed by the National Education Association.

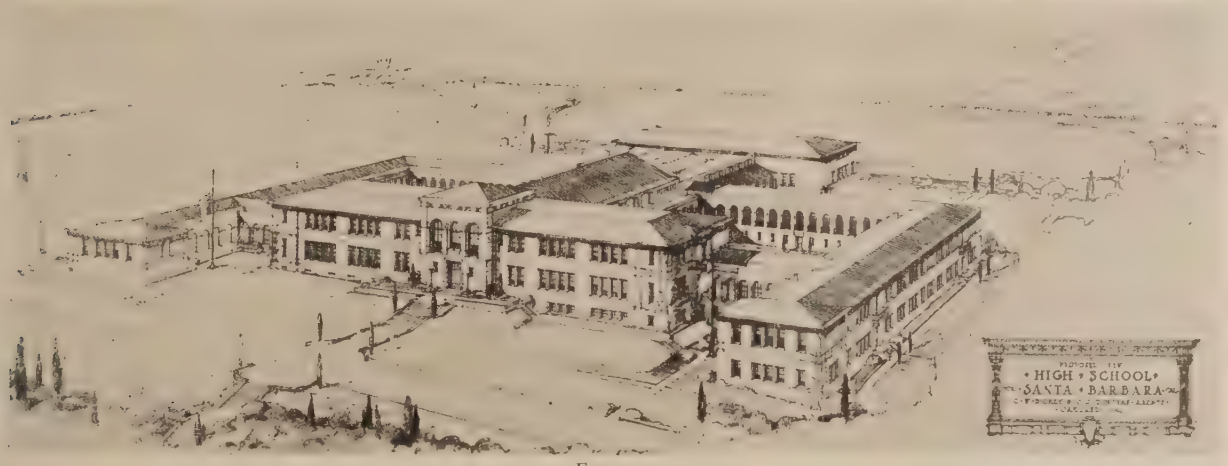


FIG. 110.

These qualities are important not only in school work but also as a preparation for citizenship in a democracy.

(*d*) The junior high school, by providing experiences in a variety of work, helps the pupil in the exploration of his aptitudes and in the wise choice of work best suited to his needs in the senior high school. For the large majority of pupils the junior high school should be prevocational rather than vocational in aim.

(*e*) The new organization makes it possible for the young children in the first six grades to obtain schooling within easy access of their homes, and brings together in junior high schools, a little farther away from the homes of some of them, a group of pupils sufficiently large to warrant the offering of the variety of work needed by pupils of varying interests and aptitudes and of varying probable destinies in life.

2. *Variations in the Three-Block System.* — Instead of the 6–3–3 system some communities have 6–2–4, 6–4–2, or 6–6 systems. The 6–2–4 system is found chiefly in places where a four-year high school is already adequately housed and the community does not feel justified in erecting a new building to care for more than the seventh and eighth years. This plan, however, is not ideal, because two years is not a sufficient period in which to realize the distinctive purposes of the junior high school. Ninth-year pupils do not associate as normally and naturally with the pupils of the senior high school as they do with those of the junior high school. Moreover the junior high school is better able to meet the educational needs of pupils in the ninth school year than can the senior high school.

In rural communities too small to maintain an effective senior high school, the 6–4–2 plan is often desirable. With this plan the pupils may obtain instruction through the tenth grade, or to the age of approximately sixteen, in a school near home, and then go to a more distant school for the eleventh and twelfth years. This plan is being effectively worked out in Vermont, where four-year junior high schools are encouraged in small towns and strong central six-year high schools are established in larger, conveniently-located centers.

In still other places the junior and senior high schools are organized as one school, or at least housed in one building, resulting in a 6–6 system. This plan is adapted to the needs of communities too small to maintain distinct junior and senior high schools, but sufficiently large to maintain an effective six-year high school. In such schools the special needs of the younger pupils must be provided for. Where the size of the school permits there may be two principals and two quite distinct student bodies sharing in the use of certain common equipment, such as the auditorium, but using such equipment at different times.

3. *Comprehensive* vs. *Special-Type High Schools.* — To meet the varied needs of high-school pupils most wisely and to safeguard and promote mutual understandings in our democracy, the author of this chapter strongly favors the comprehensive type of high school instead of the specialized high schools found in certain American cities. In some of our oldest cities specialized high schools arose naturally because the earliest schools were of an academic type, while new schools were established to provide for newer types of secondary education. The existing schools conceived their function in narrow terms, and it was feared that they would not be friendly to the development of the newer types of education. In some other cities, specialized schools are due to a failure to plan comprehensively. The shortcomings of specialized schools have already been recognized in certain cities having had such schools, with the result that specialized schools have been united to form comprehensive schools.

The arguments for the comprehensive high school are set forth as follows by the Commission on the Re-

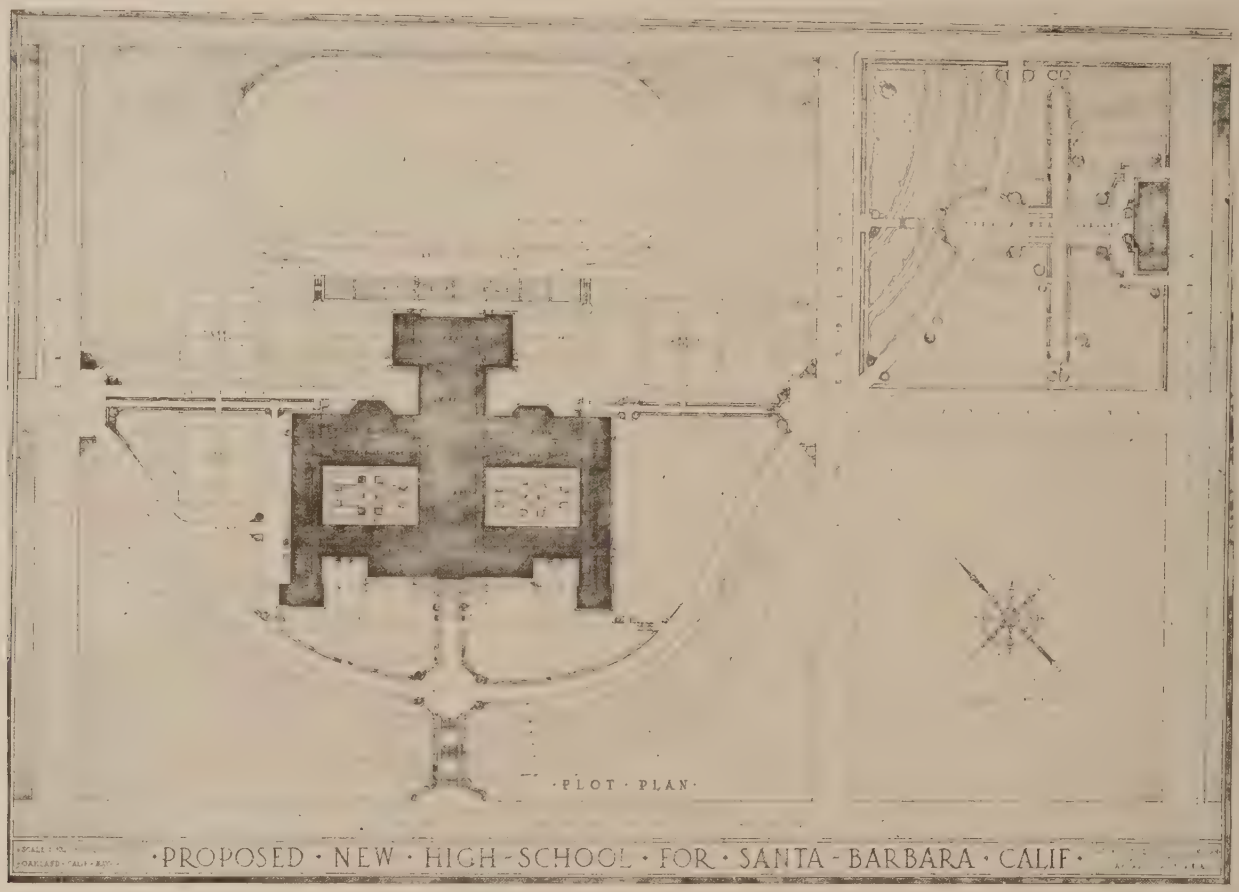


FIG. 111.

organization of Secondary Education, appointed by the National Education Association in its report entitled "Cardinal Principles of Secondary Education." [1]

"The comprehensive (sometimes called composite, or cosmopolitan) high school, embracing all curriculums in one unified organization, should remain the standard type of secondary school in the United States.

"Junior high schools must be of the comprehensive type, whatever policy be adopted for the senior high schools, since one of the primary purposes of the junior high school is to assist the pupil through a wide variety of contacts and experiences to obtain a basis for intelligent choice of his educational and vocational career. In the judgment of the commission senior high schools and four-year high schools of the older organizations should, as a rule, be of the comprehensive type, for the following reasons:

"(*a*) *For Effectiveness of Vocational Education.*—When effectively organized and administered the comprehensive high school can make differentiated education of greater value to the individual and to society, for such value depends largely upon the extent to which the individual pursues the curriculum best suited to his needs. This factor is of prime importance, although frequently ignored in discussions regarding the effectiveness of vocational and other types of differentiated education.

"In a system of special-type schools many influences interfere with the wise choice of curriculum. Thus many pupils choose the high school nearest to their homes, or the school to which their friends have gone or are going, or the school that provides the most attractive social life, or has the best athletic teams. Still others are unwisely influenced by the notions of neighbors and friends of the family. After entering a special-type school, many pupils drop out because the work is not adapted to their needs, while comparatively few transfer to another school.

"In a comprehensive school the influences interfering with a wise choice of curriculum may be reduced to a minimum. When an unwise choice has been made the pupil may be greatly aided in discovering a curriculum better adapted to his needs because he can see other work in the school, talk with school companions, and confer with teachers who are able to give him expert advice regarding such curriculums. When such a pupil

[1] Bulletin 35 for 1918, U. S. Bureau of Education.

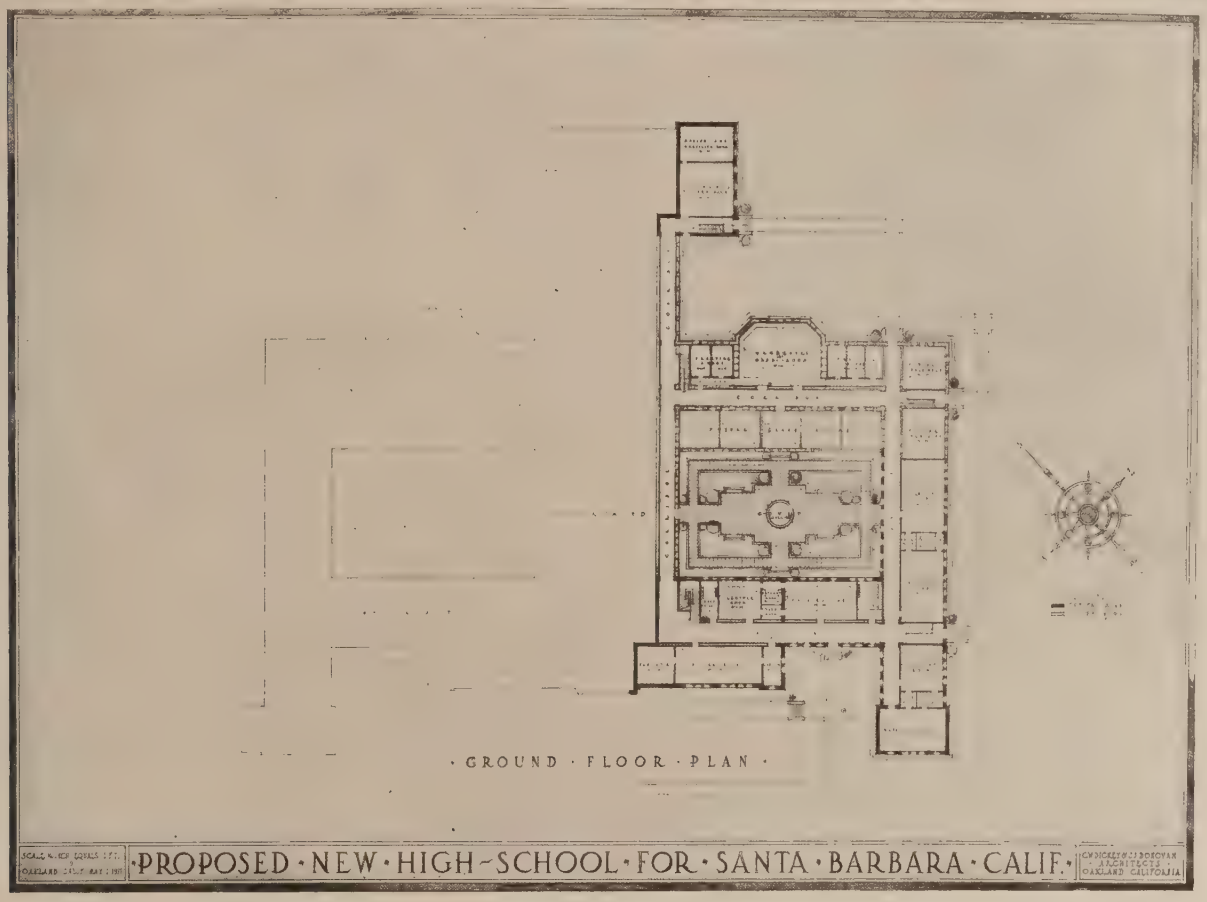


FIG. 112.

has found a curriculum better adapted to his needs, he can be transferred to it without severance of school relationships and, what seems to him, the sacrifice of school loyalty.

"Moreover, pupils in comprehensive schools have contacts valuable to them vocationally, since people in every vocation must be able to deal intelligently with those in other vocations, and employers and employees must be able to understand one another and recognize common interests. Similarly, teachers in comprehensive schools have a better opportunity to observe other curriculums and are thereby better able to advise pupils intelligently.

"Summarizing under this head, the well-organized comprehensive school can make differentiated education of greater value than can the special-type school, because it aids in a wise choice of curriculum, assists in readjustments when such are desirable, and provides for wider contacts essential to true success in every vocation.

"(*b*) *For Unification.* — When administered by a principal who himself recognizes the social value of all types of secondary education and inspires a broad spirit of democracy among teachers and pupils, the comprehensive high school is a better instrument for unification. Through friendships formed with pupils pursuing other curriculums and having vocational and educational goals widely different from their own, the pupils realize that the interests which they hold in common with others are, after all, far more important than the differences that would tend to make them antagonistic to others. Through school assemblies and organizations they acquire common ideas. Through group activities they secure training in coöperation. Through loyalty to a school which includes many groups they are prepared for loyalty to State and Nation. In short, the comprehensive school is the prototype of a democracy in which various groups must have a degree of self-consciousness as groups and yet be federated into a larger whole through the recognition of common interests and ideals. Life in such a school is a natural and valuable preparation for life in a democracy.

"(*c*) *For Objectives Other than Vocation.* — A comprehensive high school can provide much more effectively for health education, education for the worthy use of leisure, and home-making education than a number of smaller special-type schools can.

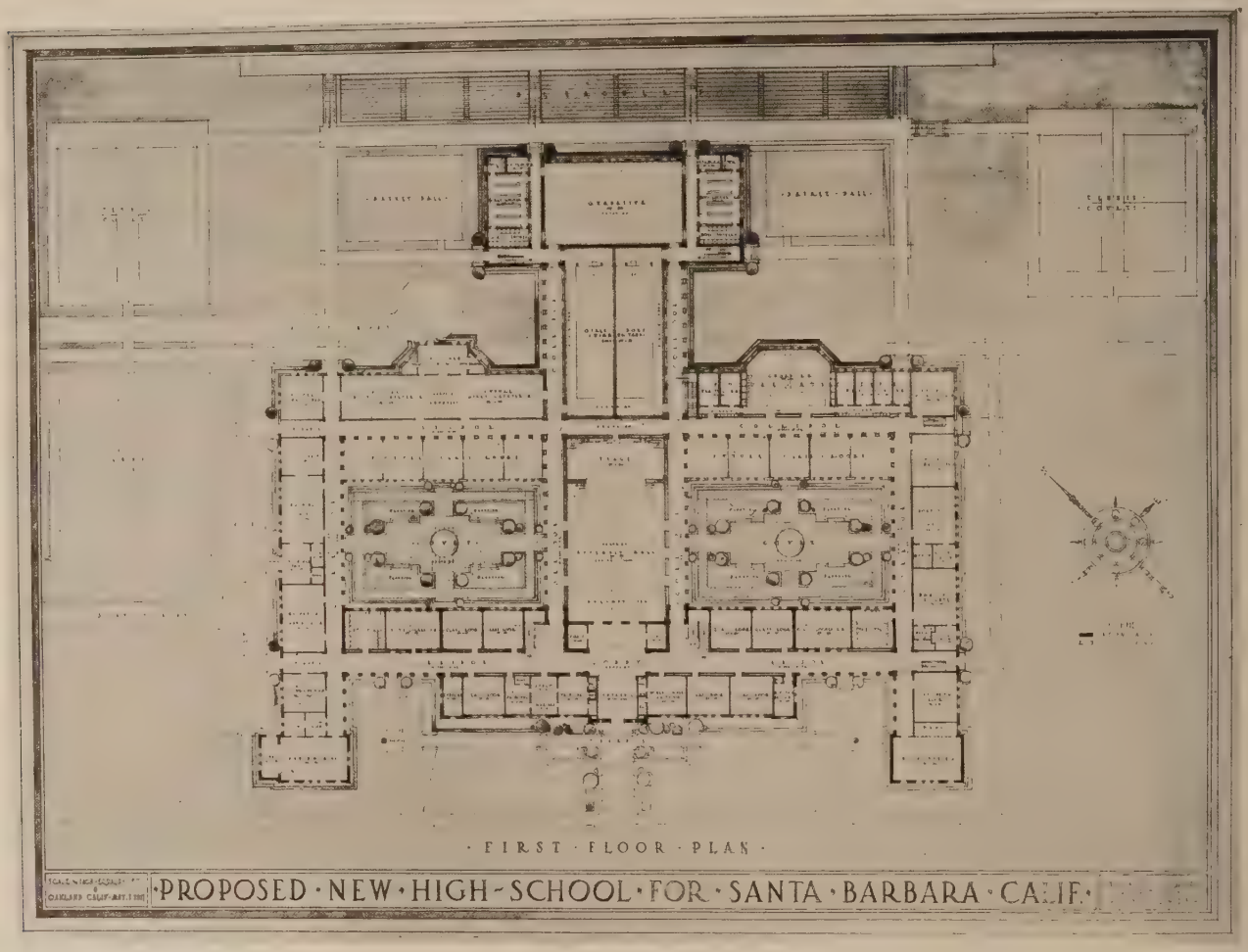


Fig. 113.

"The most effective health education requires adequate equipment and instructors competent to diagnose health needs and direct health activities. Expenses and difficulties of duplication of such facilities in every smaller special-type school are almost prohibitive. Preparation for the worthy use of leisure is best achieved when there is a wide variety of activities from which pupils may select, such as arts and crafts clubs, literary and debating societies, and musical organizations. All of these require for their success enthusiastic leadership such as can best be secured from a large faculty. Girls in all curriculums should have the advantages of work in household arts under efficient directors and with adequate equipment. Such conditions are most readily provided in the comprehensive school where there is a strong department of household arts.

"With the establishment of a special-type high school it frequently happens that various important phases of education are neglected or minimized in the other schools of that system.

"(*d*) *For Accessibility.* — In cities large enough to require more than one high school it is desirable to have each school so located as to serve a particular section of the city, thereby reducing the expense and loss of time involved in travel on the part of pupils. The proximity of the school to the homes results also in greater interest in education on the part of pupils and parents, and consequently increases the drawing and holding power of the school.

"(*e*) *Adaptation to Local Needs.* — In recommending the comprehensive high school as the standard secondary school the commission recognizes that in large cities where two or more high schools are needed it is not always possible to provide every curriculum in each high school, such a practice being precluded by the fact that certain curriculums would thereby enroll in the several schools too few pupils to permit economical organization and administration. In such cases a few curriculums may well appear in selected comprehensive schools or even in a single school only, while other curriculums appear in every school.

"The commission also recognizes the impracticability

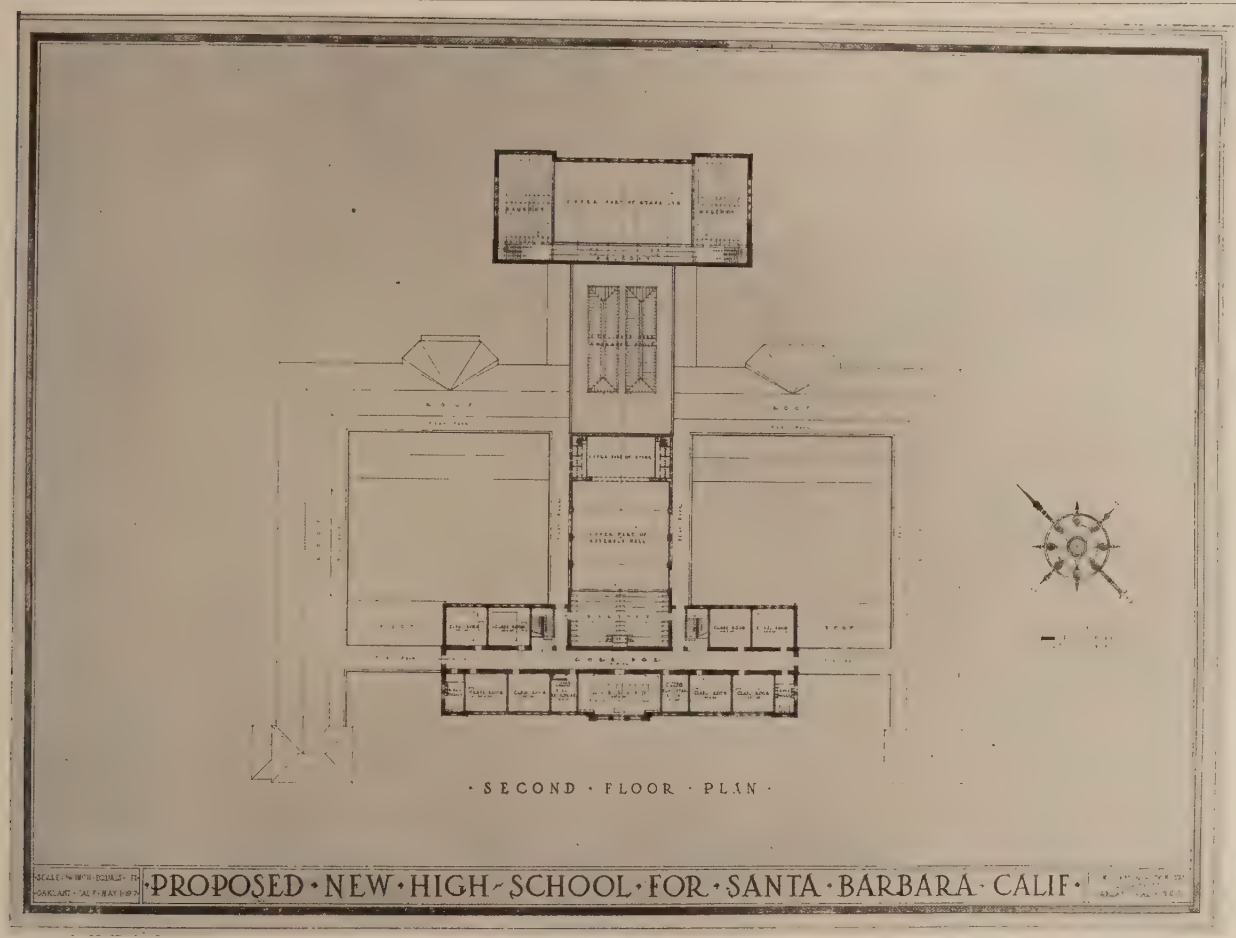


FIG. 114.

of offering every curriculum in every small rural high school. In such cases it is desirable that a curriculum for which the number of pupils does not warrant such duplication should be offered in selected schools, and that pupils needing that curriculum should go to those schools. This plan is substantially the same as that recommended for the large city.

"(*f*) *Effective Organization of Curriculums in Comprehensive High Schools.* — Finally, the commission recognizes that in the past relatively ineffective instruction has been afforded in some comprehensive schools. This has been due in part to the fact that everywhere vocational education has been passing and is still passing through a period of experimentation. The commission believes, however, that the most serious defect in vocational education in the comprehensive high school has been due to a lack of proper organization and administration. Effective vocational education cannot be secured when administered like so many accidental groupings of subjects. To remedy this situation the commission recommends that each curriculum, or group of closely related curriculums, in the large comprehensive high school be placed under the supervision of a director whose task it shall be to organize that curriculum and maintain its efficiency. The curriculum directors must work under the general direction of the principal, who must be the coördinator of all the activities of the school. Especially is it necessary that each director shall be selected with the same care that would be exercised in choosing the principal of a special-type school enrolling as many pupils as are enrolled in the curriculum or curriculums under his direction. In medium-sized high schools unable to employ directors for the various curriculums, the teachers should be organized into committees to consider the problems of the various curriculums, all working under the direction of the principal.

"Unless the various curriculums are effectively organized and administered, and unless the democratic spirit pervades the school, the comprehensive high school is in danger of failure; with these factors present, it has every promise of success."

4. *Determination of the Contributing Area for Senior High Schools.* — High schools should be so distributed that the contributing area for each school will be suffi-

ciently large to supply enough students to warrant a wide variety of curriculums, but not so large that pupils in the more remote sections of that area will be deterred from attendance, or that the cost of transportation and the time spent in travel will be excessive.

In villages and rural sections a high school should not be built until the situation has been thoroughly canvassed to ascertain whether the needs of the pupils will be best served (*a*) by building a local school, or (*b*) by furnishing tuition and transportation to an existing high school in a neighboring town or city, or (*c*) by uniting with other towns or districts in establishing a union high-school district.

In Massachusetts all school districts within township lines were abolished fifty years ago, and the city or township became the taxation unit for the support of schools. The state contains 38 such cities and 316 townships. Of these only 6 cities and 3 towns maintain more than one high school each, while 114 towns which do not maintain a high school pay the tuition and transportation of pupils to high schools in other towns or cities. The desirability of encouraging two or more towns to unite in maintaining union high schools is receiving favorable consideration.

In Illinois, school districts regardless of township lines may unite in a new taxation unit for the purpose of establishing a union high school.

In California the state and county provide generous aid to any district maintaining a high school, and a pupil may attend, without payment of tuition, any high school within the county in which he or she resides. While California has nineteen times the area of Massachusetts it has only about the same number of high schools as the latter state.

One advantage in establishing a union high-school district instead of paying tuition and transportation lies in the fact that the people in all portions of the union district may take part in the selection of the board controlling the school, and consequently the needs of the pupils from all portions are more likely to receive adequate consideration. Also, more money may be available for erecting the building.

When rural districts are within easy access of cities the question arises as to whether the needs of country youth are so different from those of city youth that an attempt should be made to send them to a union rural high school rather than to a city high school. Much may be said on both sides of this question. It is likely that their needs will be more fully met by the union rural school if that school be accessible and large enough to provide a good variety of curriculums. On the other hand, the needs of country and city youth are not sharply divided, since many city youth would profit by an agricultural curriculum, while many country youth should be prepared for professions and occupations essentially urban in character.

In small and medium-sized cities one high school, comprehensive in type, is to be preferred to two or more smaller high schools.

This comprehensive high school should offer all types of secondary education, including all varieties of trade and continuation education that may wisely be established for the young people of high-school age in that community. It is reasonable to assume that pupils living within a radius of one and a half miles will be actually benefited by walking to and from school.

A problem arising in every growing city is whether to enlarge its existing high school or to build additional schools. The solution of this problem will depend upon geographical considerations and upon the decision as to the most desirable size of high school. Contrary to the opinion frequently held, a very large high school can be administered not only economically but also effectively, provided that the school board does not practice false economy by failing to furnish the principal with the assistance which he needs for the discharge of his administrative and supervisory duties. It is seldom possible for a principal to come into close personal contact with every pupil in a school of even 500. Moreover one man cannot, unaided, devote adequate attention simultaneously to all the varied duties involved in the administration and supervision of even a medium-sized school. The best administration, therefore, involves the delegation of important duties. With the recognition of this truth the arguments for a school of restricted size largely disappear.

In cities too large in area for one high school, the city should be divided into two or more districts, each to be served by a comprehensive high school. Too frequently such cities have increased high school accommodations by the erection of special-type high schools. This method has not reduced to any appreciable extent the amount of travel and has produced many bad results educationally and socially. By the district plan excessive loss of time and money involved in travel to and from school is avoided. Each such district high school should offer all the curriculums for which there is sufficient need in its district. Any curriculum for which there is not sufficient demand to warrant duplication in all schools may be offered in one or more schools only, and pupils needing that curriculum encouraged to attend those schools. By this plan the establishment of special-type schools is avoided and all the schools have the advantages of breadth and catholicity, even though some may not have all the curriculums.

FIG. 115. — SOUTH SIDE HIGH SCHOOL, NEWARK, NEW JERSEY. *Mr. E. F. Gutlbert, Architect.*

5. *Determination of the Contributing Area for Junior High Schools.* — The contributing area for a junior high school should, in some cases, be smaller than that for a senior high school. For rural areas the Vermont plan is to be commended, whereby many smaller towns maintain four-year junior high schools containing grades 7, 8, 9, and 10, and a few centrally located, large towns or cities maintain six-year high schools containing grades 7 to 12. The four-year junior high schools are thus contributory to the central six-year high schools. By this plan the younger pupils are not exposed to the temptations and inconveniences of travel, while the older pupils who are more mature and better able to look out for themselves have the advantages of the more varied curriculums and the more elaborate equipment furnished by the larger high schools.

In large cities having two or more senior high school districts, a better coördination can be worked out between junior and senior high schools if one or more junior high school districts lie wholly within a given senior high school district.

6. *Probable Number of Pupils to be Furnished by the Contributing Area.* — After determining the contributing area, an estimate should be made as to the probable number of high school pupils who will be supplied by that area within the next few years. The following factors should be taken into consideration:

(*a*) The probable increase in the population of that area.

(*b*) The probable drawing and retentive power of the new school on account of:

(1) Attractive power of new curriculums and activities that the new building will make possible.

(2) Attractive power of the new building itself.

(3) Retentive power of improved methods of instruction.

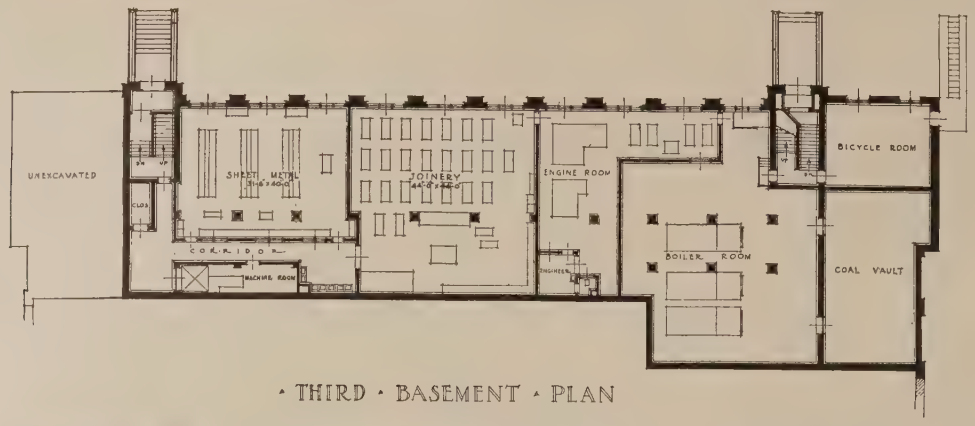
(*c*) The probable changes in compulsory school laws, such as the raising of the compulsory school age.

Seldom do school boards make sufficient allowance for these increases. As a result new buildings are generally overcrowded soon after their erection. In many communities the high school attendance is rapidly approaching the total number of pupils of high school age living in the contributing area. There is little

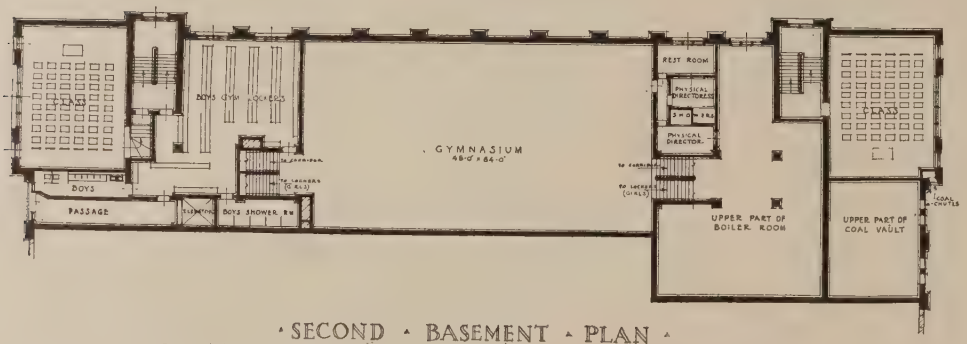
FIG. 116. — SOUTH SIDE HIGH SCHOOL, NEWARK, NEW JERSEY.

Mr. E. F. Guilbert, Architect.

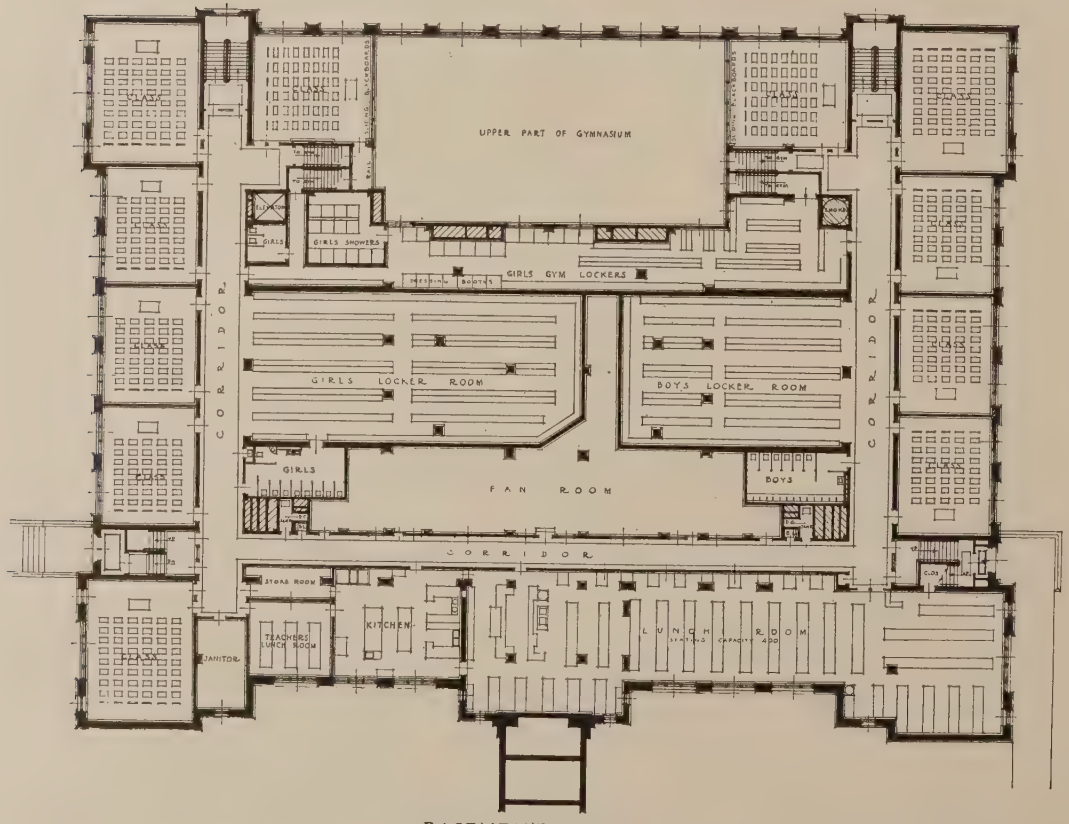
FIG. 117. — SOUTH SIDE HIGH SCHOOL, NEWARK, NEW JERSEY. *Mr. E. F. Guilbert, Architect.*



THIRD BASEMENT PLAN

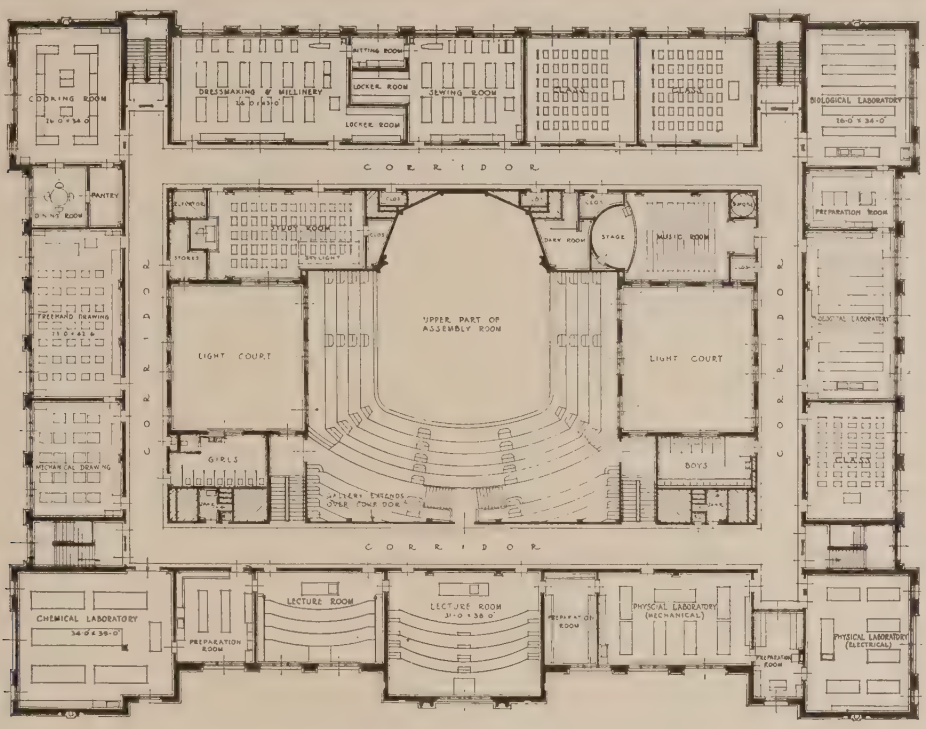


SECOND BASEMENT PLAN
SOUTH SIDE HIGH SCHOOL — NEWARK, N.J.



BASEMENT PLAN
SOUTH SIDE HIGH SCHOOL — NEWARK, N.J.

FIG. 118. *Mr. E. F. Guilbert, Architect.*



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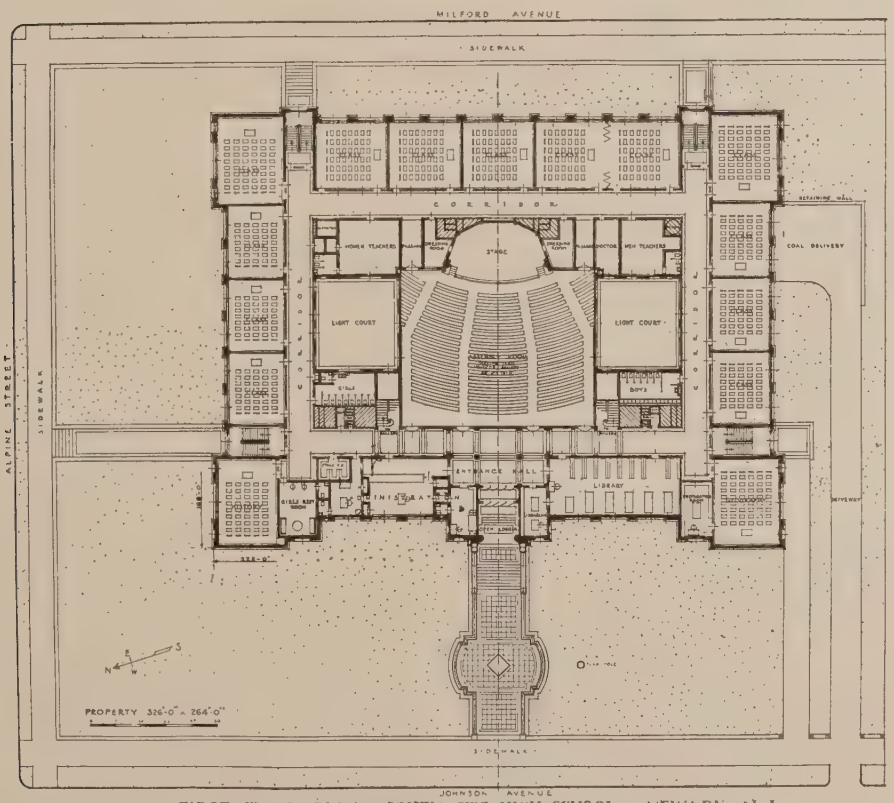
· SOUTH · SIDE · HIGH · SCHOOL — NEWARK, N·J ·



· FIRST · FLOOR · PLAN — SOUTH · SIDE · HIGH · SCHOOL — NEWARK, N·J.
· CONSTRUCTION · DEPARTMENT — BOARD · OF · EDUCATION ·
E P GUILBERT · ARCHITECT · W KNIGHT · ENGINEER

FIG. 119.

doubt that the time is not far distant when the compulsory school age will be raised first to sixteen, and finally to eighteen.

In rapidly growing communities it is not to be expected that a high school will be built large enough to provide for more than five or ten years of growth. Consequently every such school should be so planned that it can be economically and efficiently enlarged. For this purpose certain facilities should be constructed at the outset with reference to the ultimate capacity of the school, while other facilities, such as additional classrooms, may be deferred.

II. **Internal Organization as Affecting Accommodations.** — After determining the number of pupils to be accommodated, the internal organization of the high school should be mapped out by the educational authorities. If the school which is to occupy the building is a new organization and a large one, the principal who is to administer it should be selected at once and given ample time in which to work out every detail. He should visit the best schools in the country and make a scientific analysis of every problem. He should outline the program of studies, estimate the number of pupils likely to take each subject, and determine the number of classes in each subject, so as to ascertain the size and number of rooms needed for each type of work.

1. *Flexibility.* — As these estimates can be merely provisional, and since secondary education is undergoing rapid changes as to curriculums, class organization, and methods of instruction, no effort should be spared to make the building so flexible that changes can be made, when necessary, with the minimum of expense. One of the best devices for securing flexibility in a building consists in placing all heating and ventilating ducts in the walls between the rooms and the corridors, making partitions between rooms non-supporting. This principle should be regarded as fundamental in all high school construction.

2. *Program of Studies.* — It would not be possible within the limits of this chapter to discuss the principles underlying the organization of a modern program of studies. Reference may be made, however, to the report[1] of the Commission on the Reorganization of Secondary Education setting forth the seven main objectives of education which should find recognition in the work of every high school student. These objectives are held to be: Health, command of fundamental processes, worthy home membership, vocation, citizenship, worthy use of leisure, and ethical character.

Four of these objectives have a direct bearing upon buildings, as follows: health demands adequate gymnasiums, shower baths, outdoor equipment for games, sanitary and hygienic buildings, and lunch rooms where pupils may be seated when they eat; worthy home-membership requires equipment for teaching all phases of home-making; vocation calls for a wide variety of equipment for commercial, agricultural, and industrial curriculums; and the worthy use of leisure gives a new significance to the school library, equipment for school dramatics, provision for school bands and orchestras, art instruction, and the embodiment of good taste in the building itself.

Among the other factors of school organization which have a distinct bearing upon the building we will discuss the following, but would caution the reader that the conclusions reached must be regarded as tentative. It is to be hoped that the analysis here presented will stimulate others to make detailed investigations.

3. *Staff of the School.* — In order that the building may provide for all the activities of the school, there should be an analysis of the functions of the staff of the school, and rooms other than recitation rooms should be provided for certain of these functions. The larger the school, the greater should be the subdivision of labor, and the more specific should be the provisions in the building for the discharge of these functions. The following analysis is suggested:

General administration vested in the Principal	Instruction — Teachers
	Supervision of Instruction — Heads of departments, and curriculum directors
	Educational and vocational guidance — Director
	Personal service — Dean of girls
	Library service — Librarian and, in the large school, assistant librarians
	Clerical service — Clerk or clerks
	Health service — Physical training teachers, school physician, and school nurse
	Luncheon service — Director and employees
	Recreation — Director
	Janitorial service — Janitor and, in the large school, assistant janitors

Heretofore the importance of the functions other than instruction has frequently been underestimated. Without curriculum directors instruction has been thought of too largely in terms of subjects of study with too little reference to the adaptation of these studies to larger ends. Educational and vocational guidance has been left to the individual teachers without the broader prospective which a director could establish. The

[1] Cardinal Principles of Secondary Education, Bulletin 35 for 1918, U. S. Bureau of Education.

administration of the library has been placed in the hands of teachers without training in library methods and without a knowledge of the best books for high school students. Inadequate clerical service has overburdened the teachers with clerical routine which they are unable to discharge effectively. The absence of school nurses makes it impossible for the advice of the school physician to be carried out. The lunch room must have a competent director in order that the health of pupils may be promoted. A director of recreation can organize school pageants and put the recreation of young people on a high plane. An adequate janitorial service is necessary in order that the building may be sanitary and embody high standards of cleanliness.

Heads of departments, curriculum directors, and the director of recreation will ordinarily be teachers who give only a part of their time to these administrative duties. In the medium-sized school the director of educational and vocational guidance and the dean of girls may also do some teaching.

The main office may well accommodate the clerks, while the principal and some of the other administrators should have offices connecting with the main office. In the large school the heads of some of the departments should have offices which correlate with the other rooms of their respective departments. The offices of heads of the English and social studies departments should correlate with the library, which is really the laboratory for those departments. The offices of the health service may well correlate with the gymnasium.

4. *Size of Laboratories and Shops.* It is a common error to make laboratories and shops too small. Adequate space in these rooms is necessary in order to accommodate a sufficient variety of equipment of proper size. Shops should also contain space for the assembling of large pieces. In rooms for subjects like mechanical drawing and bookkeeping there should be space for a few advanced students to do some additional individual work in their free periods at the same time that regular classes are being instructed in the same room, as some of this individual work can be conducted with the occasional help of the teacher.

In some kinds of shop work and in mechanical drawing it is often feasible and desirable to place more than one teacher in a given room. By so doing younger assistants may have the constant advice of more experienced teachers.

The advantages of a general shop containing a wide variety of equipment should be considered, especially for the small and medium-sized high school.

5. *Size of Classrooms.* — The size of classrooms should be determined by the size of classes that can be taught effectively. As will be discussed later, a classroom should not be designed to accommodate study pupils in rear seats — a plan sometimes used, but highly inadvisable. Neither should classrooms have additional seats in order to accommodate more home-room sittings, because study halls, commercial rooms, and many rooms designed primarily as for other special purposes can also furnish home-room accommodations, thereby effecting great economy and efficiency. The number of home-room sittings should be ascertained in every building, but the real problem is that of providing a sufficient number of rooms, of various types and of proper size, for all the activities of the school.

It may be laid down as a general principle that classes of more than 30 pupils are not desirable. It is, however, impossible to arrange a schedule so that all classes will be uniform in size. Some classes are necessarily quite small. To avoid having too many small classes, with the resulting high cost of instruction, it is necessary in some schools to avoid making two sections of a class in a given subject when the total number does not exceed 36 pupils. Since a classroom seating 36 pupils, with six rows and six seats in a row, makes a good classroom, it may not be inadvisable in some large schools where strict economy must be exercised to adopt 36 as the standard size for classrooms, but in schools with greater financial ability where classes can be kept down in size, 30 is a wiser standard.

In medium-sized schools, especially where many of the teachers are inexperienced, the standard should not exceed 30.

In small schools, of say less than 200 pupils, it may be desirable to reduce the standard to 24-pupil classrooms.

On account of the large number of small classes found in most schools some persons favor the construction of a number of small recitation rooms. This practice, however, is open to serious objection, because the saving effected in space does not compensate for the loss in teaching efficiency involved in the change in room every time that the teacher has a small class. Progressive teachers collect and arrange illustrative material for their work, adding greatly to the effectiveness of instruction. This material cannot well be moved from room to room between periods.

On the other hand, it will occasionally be found desirable to have classes larger than the standard adopted. To accommodate such classes there will be need for a few classrooms larger than the standard. Such rooms may accommodate 36 pupils in schools where 30 is the standard and 30 pupils where 24 is the standard. The saving effected by having only a few large rooms and keeping the size of all the other classrooms down to a smaller standard is very considerable. In fact the saving warrants the loss of efficiency involved in the compara-

tively few times that a teacher must change rooms because of oversized classes.

6. *Actual Size of Classes.* — On account of promotion by subjects and the variety of courses offered in the modern high school there is necessarily considerable variation in the size of classes. When the number of periods in the school day is increased and the science of schedule-making is perfected, it will be possible to have less variation than is frequently found to-day, thereby increasing the efficiency of the schools.

The following tables show the actual variations in size of classes as revealed by a survey of Massachusetts high schools made by the author in 1916–1917. These tables give the number of classes and percentage of classes of various sizes in 240 high schools. The only public high schools not included were the 15 Boston high schools in which the conditions were abnormal, and one small-sized high school. To show the conditions in schools of different sizes the schools were grouped as follows:

Group I.	42 high schools each having over 500 pupils
Group II.	46 high schools each having 201 to 500 pupils
Group III.	48 high schools each having 101 to 200 pupils
Group IV.	52 high schools each having 51 to 100 pupils
Group V.	52 high schools each having 1 to 50 pupils

Number of Classes of Various Sizes
(Exclusive of Classes in Music and Physical Training)

Size of Class	Classes in					
	Group I	Group II	Group III	Group IV	Group V	Total
1– 5 pupils	96	100	144	190	254	784
6–10 pupils	371	397	306	404	309	1,787
11–15 pupils	965	616	458	320	230	2,589
16–20 pupils	1,874	859	434	269	91	3,527
21–25 pupils	2,181	754	292	130	36	3,393
26–30 pupils	1,854	535	188	33	7	2,617
31–35 pupils	876	273	70	16	5	1,240
Over 35 pupils	322	121	26	8		477
Total	8,539	3,655	1,918	1,370	932	16,414
Number of high schools	42	46	48	52	52	240

Per Cent of Classes of Various Sizes
(Exclusive of Classes in Music and Physical Training)

Size of Class	Per Cent of Classes in					
	Group I	Group II	Group III	Group IV	Group V	Total
1– 5 pupils	1	3	8	14	27	4.6
6–10 pupils	4	11	16	29	33	10.9
11–15 pupils	11	17	24	23	25	15.8
16–20 pupils	22	23	23	20	10	21.5
21–25 pupils	26	21	15	9	4	20.7
26–30 pupils	22	15	10	2	1	16.0
31–35 pupils	10	7	4	1	1	7.6
Over 35 pupils	4	3	1	1		2.9
Total	100	100	100	100	100	100.0
Number of high schools	42	46	48	52	52	240

From the above tables it appears that:

35-pupil rooms would accommodate —

96% of the classes in schools of over 500 pupils.

97% of the classes in schools of 201 to 500 pupils.

99% to 100% of the classes in schools of not over 200 pupils.

30-pupil rooms would accommodate —

86% of the classes in schools of over 500 pupils.

90% of the classes in schools of 201 to 500 pupils.

95% to 100% of the classes in schools of not over 200 pupils.

25-pupil rooms would accommodate —

85% of the classes in schools of 101 to 200 pupils.

96% to 98% of the classes in schools of not over 100 pupils.

In connection with these tables it should be stated that many of the schools did not show such a wide variation in size of classes as did others. Some of the schools had but five periods in the school day, thus making readjustments in the size of classes difficult. On the other hand, the vast majority of schools promoted but once a year, thereby tending to diminish the number of undersized classes. With annual promotions, an increase in the number of periods in the school day, and continual improvement in the science of schedule-making, it may be possible to reduce the proportion of oversized and undersized classes and consequently to increase the proportion of normal-sized classes.

7. *Provisions for Study.* — An important factor in educational efficiency consists in the success with which pupils use the time available for study at school. An important factor in the efficiency of a building, therefore, consists in satisfactory provisions for study. To solve this problem it is necessary to determine the kind of provisions to be made, the number of study-sittings required, the most desirable size of study halls, and their articulation with the school library.

(*a*) *Kind of Provisions to be Made.* — The different methods of providing for study may be analyzed as follows:

- In class periods
  - (Directed study) . . . . . In same period and room as recitation, and in charge of teacher of given subject
- In free periods (Undirected study)
  - Quiet plan
    - Study hall
    - Library
    - Spare classrooms
  - Rear-seat plan

The term *directed study* may be applied to study in a given subject under the direct guidance of, and in the recitation room of, the teacher of that subject. This type is sometimes called supervised study, but the term is not satisfactory because all study should be supervised to some extent. Directed study is coming to be

Mr. Wm. B. Ittner, Architect.

FIG. 120. — GROVER CLEVELAND HIGH SCHOOL, ST. LOUIS, MISSOURI.

FIG. 121. — GROVER CLEVELAND HIGH SCHOOL, ST. LOUIS, MISSOURI. *Mr. Wm. B. Ittner, Architect.*

recognized as of great importance, some of the chief reasons being as follows: (1) Pupils may be taught the most effective methods of work in the particular subject. (2) The teacher may gain a clearer idea of the needs of the pupils, both individually and collectively, and as a result be better able to adapt the work to those needs. (3) A better mutual understanding and a more helpful attitude may be established between pupil and teacher.

To provide for directed study the class period, instead of being only 40 to 50 minutes, is lengthened to 60 to 90 minutes, thereby providing for both recitation and study in the same period without change of room during the period.

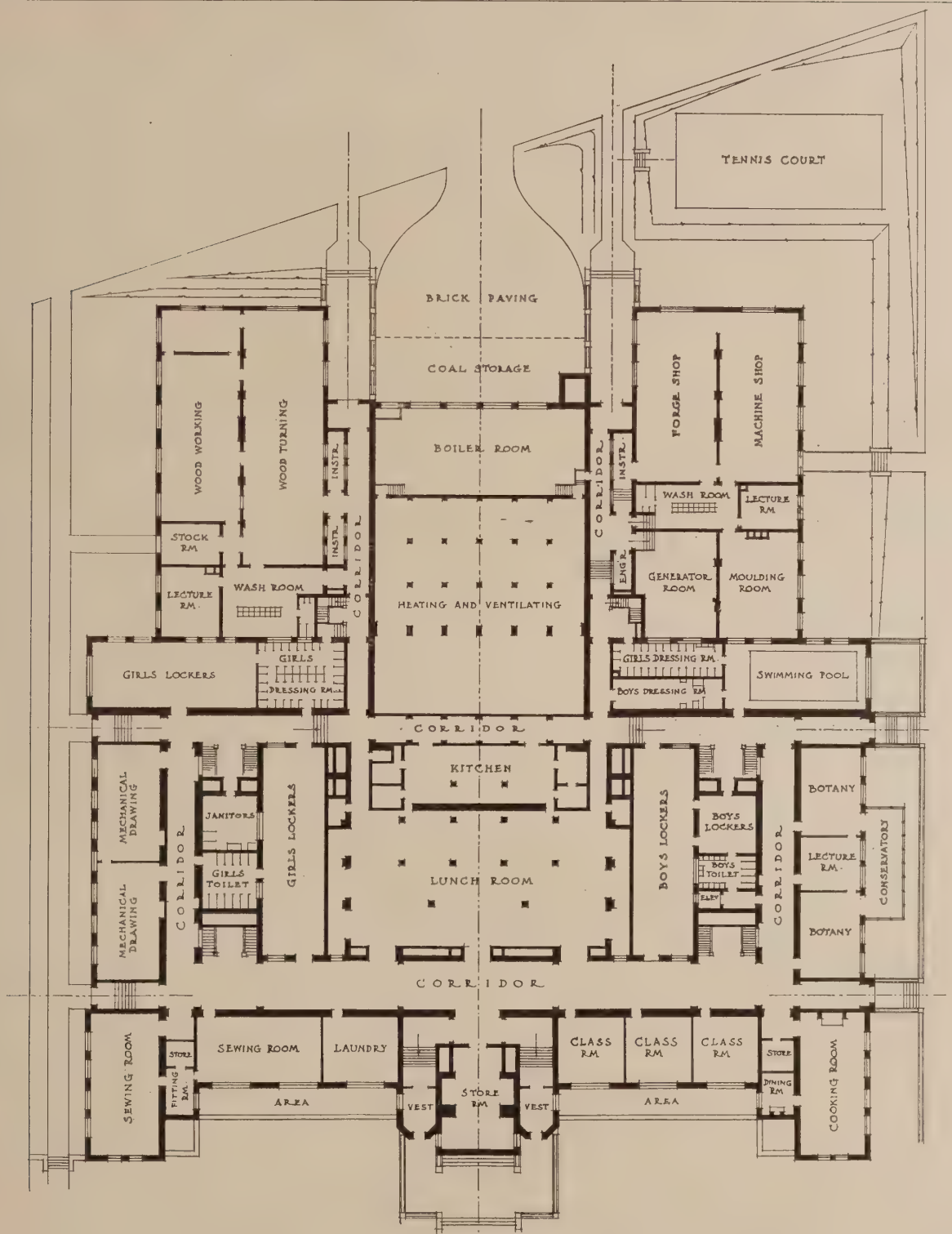
The term *undirected study* may be applied when different pupils are studying different subjects in any given room and when, as a consequence, the teacher in charge generally gives no specific guidance but exercises only general supervision to see that all the pupils keep busy.

Undirected study should be conducted in study halls especially designed and set apart for the purpose, or in the library, or in classrooms which are not used at the time for recitations.

The plan whereby rear seats in a classroom are utilized for study is objectionable for three reasons: (1) Study pupils are not able to concentrate their attention upon the work in hand; (2) the teacher is not able to give even occasional assistance to the study pupils without taking attention away from the recitation group; and (3) the teacher is not able to make the work for the recitation group vitally interesting for fear of disturbing the study pupils. The third of these reasons for not using rear seats for study is the most important. A teacher once admitted that he had actually abandoned a vital and interesting method of teaching a given subject because, he said, it was not suitable for use in a room in which other pupils were studying. Undoubtedly many other teachers have stultified their methods for this reason. Any plan of organization which discourages good instruction is deplorable.

In conclusion, therefore, as much of the study as possible should be of the first type, namely "directed study," and all undirected study should be in study halls, or libraries, or classrooms not used at the time for recitations.

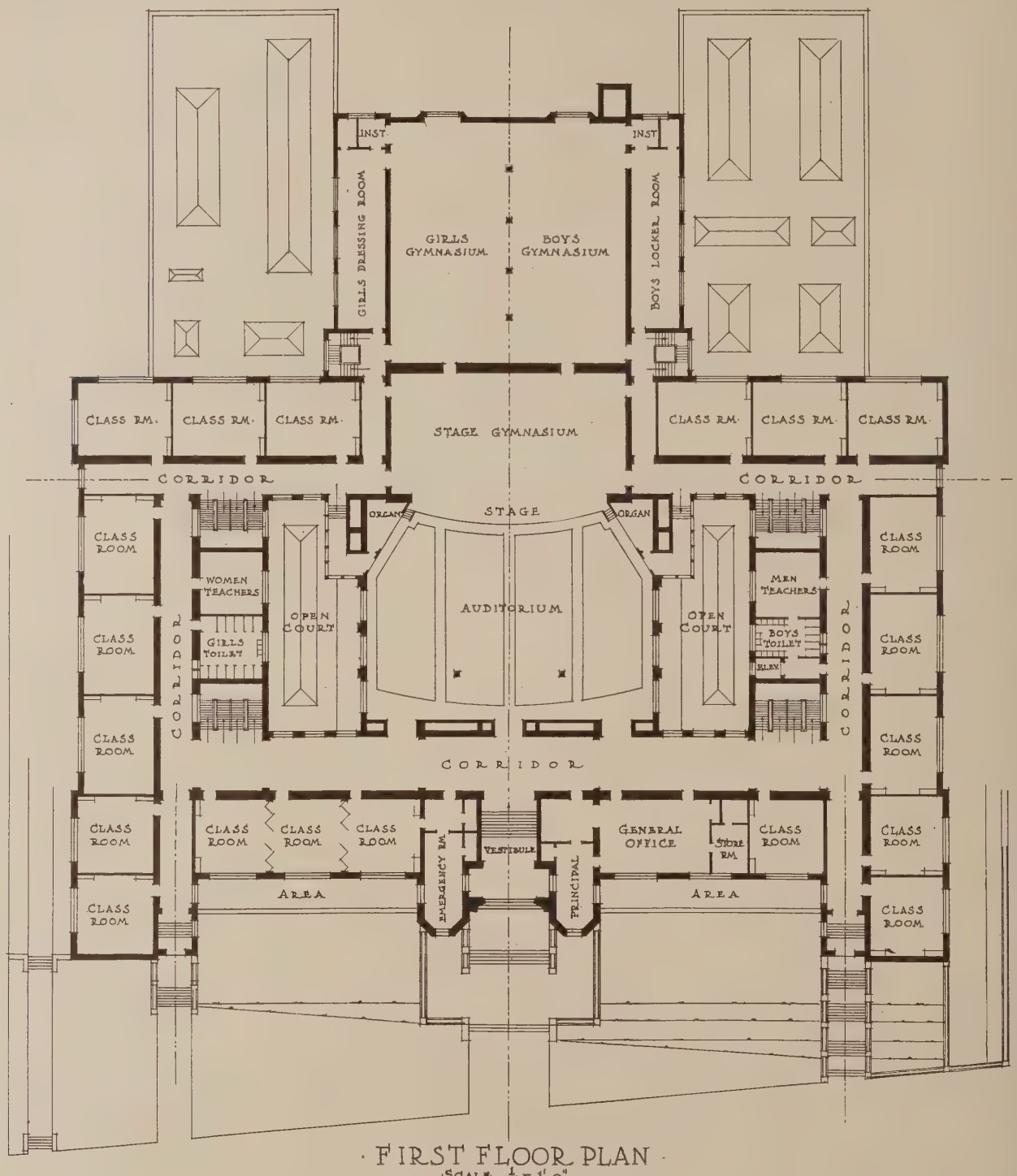
(*b*) *Number of Study-sittings Required.* — Distinct



GROUND FLOOR PLAN
SCALE $\frac{1}{32}$" = 1'-0"

GROVER CLEVELAND HIGH SCHOOL
ST. LOUIS, MO
WM. B. ITTNER, ARCHITECT. ST. LOUIS, MO

FIG. 122.

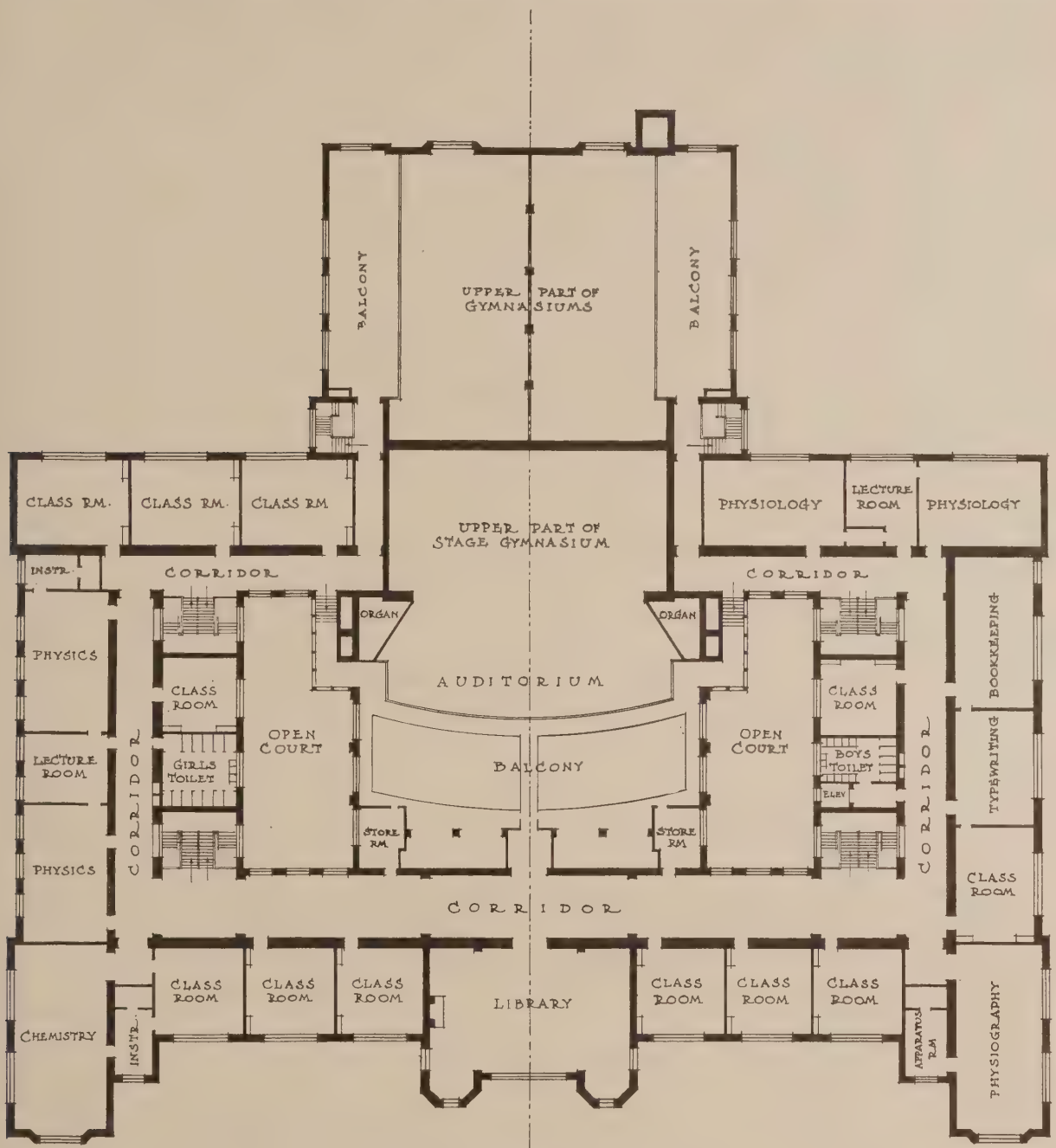


FIRST FLOOR PLAN

SCALE - $\frac{1}{32}$ = 1'-0"

GROVER CLEVELAND HIGH SCHOOL
ST. LOUIS. MO.
WM. B. ITTNER. ARCHITECT. ST. LOUIS. MO.

FIG. 123.



SECOND FLOOR PLAN

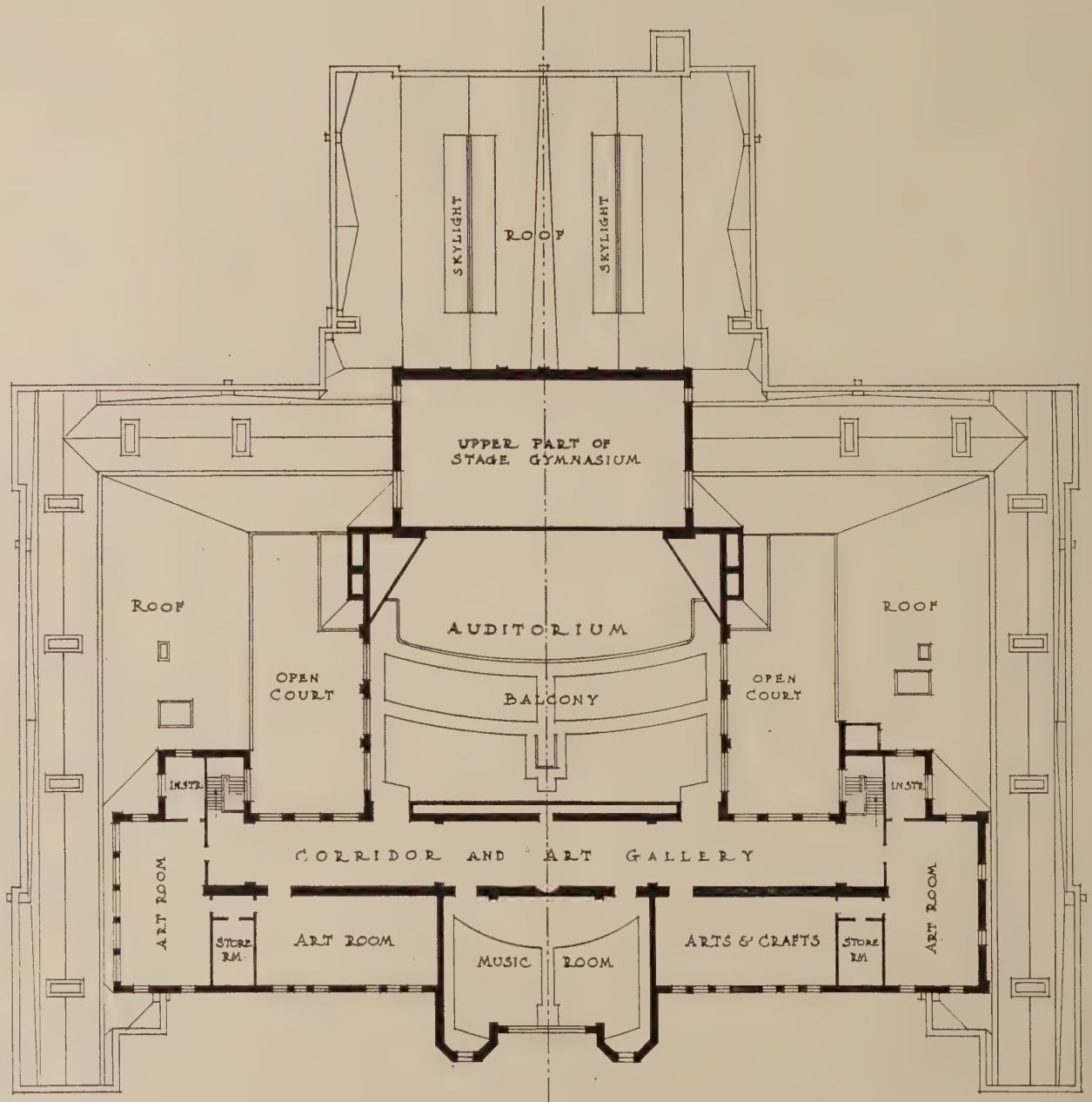
SCALE - $\frac{1}{32}$" = 1'-0"

GROVER CLEVELAND HIGH SCHOOL

ST. LOUIS. MO.

WM. B. ITTNER. ARCHITECT. ST. LOUIS. MO.

FIG. 124.



THIRD FLOOR PLAN

SCALE-$\frac{1}{32}$" = 1'-0"

GROVER CLEVELAND HIGH SCHOOL
ST. LOUIS. MO.
WM. B. ITTNER. ARCHITECT. ST. LOUIS. MO.

FIG. 125.

study-sittings need not be provided for directed study, as it is conducted in regular classrooms in the lengthened school periods.

In a large well-organized school the number of pupils in undirected study need not vary greatly in the different periods, if the entire plant is used economically. Nevertheless there will be some variation. To allow for such variation the number of study-sittings should probably be from 15% to 25% greater than the average number used. In medium-sized schools of from 300 to 500 pupils, the number of study-sittings might exceed the average used by probably 20% to 40%. In any period in which this margin does not suffice, it is probable that classrooms not used for regular classes at that time and the library may take care of those who cannot be seated in the study halls.

The average number of pupils who will need study-sittings may be obtained by the formula,

$$a = p \times \frac{f}{w}$$

in which

a = average number of study-sittings,
p = pupils to be accommodated in the school,
f = average number of free periods of each pupil per week,
w = periods in the schedule per week.

For instance, in a school planned for 1000 pupils, if each pupil is likely to have 6 free periods for undirected study in a week of 35 periods, then

Average number of study-sittings occupied $= 1000 \times \frac{6}{35} = 171$.

In such a school the study halls should provide for a margin of 15 per cent to 25 per cent, or a total of 197 to 214 pupils.

(*c*) *Size of Study Halls.* — Observation leads the author of this chapter to regard as ideal a study hall seating 72 pupils, with six rows and twelve seats in a row, in which the teacher's desk is on a platform about 15 inches in height. Aside from the problem of discipline, a larger study hall is not likely to be efficient, because the attention of pupils is diverted to some extent by the normal entrance and exit of pupils, and by other inevitable interruptions which increase in frequency as the number of pupils is increased.

(*d*) *Articulation of Study Halls with the Library.* — It is of the utmost importance that the study hall should articulate with the library by means of a door or passageway. By this method a pupil may have free access to the library during any study period without the necessity of securing a pass. This plan relieves both the teacher in charge of the study hall and the librarian of needless clerical work, and results in greatly increased use of the library. The efficiency of the library is greatly impaired under other plans.

In a school requiring two study halls, they should be located with the library between them. If more than two study halls are needed, each pupil should have certain study periods in those study halls which do articulate with the library.

8. *Time-Allotment for Physical Training.* — The number of pupils who can be accommodated by a given gymnasium will depend upon the time-allotment for physical training and the length of the school day.

The efficiency of many high-school gymnasiums is reduced almost to the vanishing point by an inadequate time-allotment for the work. A single period of 40 to 50 minutes makes it impossible for the students to change to gymnasium suits, obtain the vigorous exercises or recreative games necessary for health, and follow these with the shower bath. A period of 60 minutes is hardly adequate for these purposes, especially for the girls, as they require more time than the boys for the showers and dressing. The following quotation from a report of the Commission on the Reorganization of Secondary Education, entitled "Physical Education in Secondary Schools," [1] shows how double periods for physical education may be inserted in a high school schedule and at the same time put the gymnasium floor to continuous use, thereby accommodating the maximum number of pupils.

"Sample Arrangement of Double Gymnasium Periods in a High-School Schedule

Group I	15 Hygiene. 15 Undress.	Ex. 45.	15 Bath.	Class 45.	Class 45.	Class 45.	Class 45.	Class 45.		
Group II	Class 45.	15 Hygiene. 15 Undress.	Ex. 45	15 Bath.	Class 45.	Class 45.	Class 45.	Class 45.		
Group III	Class 45.	Class 45.	15 Hygiene. 15 Undress.	Ex. 45.	15 Bath.	Class 45.	Class 45.	Class 45.		
Group IV	Class 45.	Class 45.	Class 45.	15 Hygiene. 15 Undress.	Ex. 45.	15 Bath.	Class 45.	Class 45.		
Group V	Class 45.	Class 45.	Class 45.	Class 45.	15 Hygiene. 15 Undress.	Ex. 45.	15 Bath.	Class 45.		
Group VI	Class 45.	Class 45.	Class 45.	Class 45.	Class 45.	15 Hygiene. 15 Undress.	Ex. 45.	15 Bath.		
Group VII	Class 45.	Class 45.	Class 45.	Class 45.	Class 45.	Class 45.	15 Hygiene. 15 Undress.	Ex. 45.	15 Bath.	

[1] Bulletin 50 for 1917 of the U. S. Bureau of Education.

"This schedule provides for seven classes of 50 pupils each; that is, theoretically 350 pupils per day per gymnasium, or 875 different pupils on the basis of two double periods per week for each pupil. This arrangement uses the gymnasium continuously and allows for alternation of two teachers in instruction in hygiene, physical education practice, and supervision of the bathing. Three hours of instruction during the school day, plus two hours on the playground and in the gymnasium or pool after school, should be the maximum requirement for one teacher. The remainder of the day is needed for administration and the keeping up of equipment, records, etc."

9. *Number of Periods in the School Day.* — The number of periods in the school day has a direct bearing upon the accommodations needed. If the school day contains only five or six periods there will be need for relatively few study-sittings. With an increase in the number of periods more study-sittings will be needed, but the number of classrooms may be reduced, as each room can be used a greater number of periods. In a large school an increase in the number of periods will also decrease the need for duplication of laboratories and shops of any given kind, will permit the gymnasium to be used for a larger number of classes, and will permit more extended use of all equipment.

The number of periods in the school day cannot be satisfactorily determined without considering the desirable length of period and the desirable length of school day.

(*a*) *Length of Period.* — Periods uniformly less than 40 minutes are generally regarded as too short. The majority of accredited high schools have periods 40 to 50 minutes in length. Moreover, a single period of 40 to 50 minutes is too short for much of the work in household arts, industrial arts, and laboratory science. Consequently, in the modern school having 40- or 50-minute periods, such work as cannot be successfully conducted in single periods is given two or three consecutive periods, called double or triple periods. Long periods are also necessary for physical training, as indicated in the preceding section.

In some schools directed study has been introduced in selected subjects, assigning double periods to them. If, however, all subjects are given double 40-minute periods daily, a very long school day will result. To allow for directed study without establishing such a long school day, some schools are adopting the 60-minute period. This period is well adapted to laboratory work and drawing and some kinds of shopwork, while the double 60-minute period is none too long for other kinds of shopwork. The 60-minute period, however, is not quite long enough for physical training, especially for girls' classes.

A third plan, recommended by the author in a survey of the Clinton (Mass.) High School, consists of a combination of long and short periods so arranged that every subject which comes daily has during the week two or three 65-minute periods and three or two short 40-minute periods. This plan provides for the limited introduction of supervised study in such a form as to increase the probability of its success, eliminates the necessity of scheduling special double periods for laboratory work, and gives gymnasium periods of 65 and 80 minutes. (For details, see appendix.)

(*b*) *Length of School Day.* — By the net length of the school day we mean the time exclusive of intermissions for lunch or recess. A net school day of less than five hours should be condemned as too short. It does not permit the school to devote sufficient time to physical training, drawing, music, household arts, and shopwork. It allows the pupil very little time for study at school and for the use of the school library. The present tendency may be said to be in favor of a school day of six hours net, with a seven-hour day for pupils taking a large amount of shopwork.

The conception that the school day must begin and end at the same time for all pupils and for all teachers will undoubtedly, and should, disappear in the well-organized comprehensive high school. The tendency to break down the fixed school day will be further increased with the development of part-time, or continuation education, as pupils will come and go at all times in the day.

In some schools many pupils find it necessary to work afternoons. These pupils should have every encouragement to continue their schooling. At the same time, it is not fair to reduce the schooling of the other pupils. To adjust the work to these two groups of pupils the schedule may be so arranged from year to year that pupils who must work afternoons may obtain a complete high-school course by taking less work each year and by spending one extra year in school. By this plan they will not be placed under an excessive strain and the quality of their work may be preserved, while the pupils who can devote all their time to school work may complete a standard high-school course in the regular number of years. (For details of such a plan, see appendix.)

III. **Estimate and Tabulation of Accommodations Needed.** — After working out the internal organization of the high school, an estimate may be made of the number of rooms of each kind needed, the kinds of equipment, the number of pupils to be accommodated, and finally the area or dimensions of each room. If these conclusions are presented in some tabular form it will be much easier to analyze, criticize, and com-

prehend them, and to check up the sketch plans after they are prepared. A brief tabular form is suggested in this chapter, but it would probably be desirable to add more details regarding equipment and to give the area or dimensions of each room.

1. *Multiple Uses.* — Many high-school rooms, if used for only one special purpose, would be unoccupied most of the time. Furthermore, flexibility of organization is promoted when there is some leeway in the number of rooms available for a given purpose. Consequently, rooms which are not likely to be used continuously for the distinctive purpose for which they are especially designed should, whenever feasible, be so constructed that they may be used at other times for some supplementary purpose or purposes.

In a small or medium-sized high school, it is not feasible to include so great a variety of rooms as would be appropriate in a large high school. If, however, the principle of multiple uses is utilized so that rooms may be used continuously, for different purposes at different times, then a small building can provide for all the more important needs of the school at reasonable cost.

The application of the principle of multiple uses in small high schools may be illustrated as follows:

(*a*) *Laboratory-Recitation Rooms.* — In small and medium-sized schools physics laboratories are seldom used continuously for physics classes. Blackboards and tablet-armchairs are desirable as supplementary equipment in such a room for classwork in physics. With such supplementary equipment, the room may readily be used for recitations in other subjects as well.

Biological laboratories, if equipped with low tables and chairs, may also be used for recitations in other subjects.

In the small or medium-sized school it is often desirable to offer physics and chemistry in alternate years. Hence, one laboratory may be equipped with convertible tables and used for both sciences, and also if equipped with tablet-armchairs may be used for recitations in other subjects.

(*b*) *Gymnasium-Assembly Hall.* — Communities building small or medium-sized schools often find that they cannot afford to build both an adequate gymnasium and an assembly hall large enough for some of the most important occasions. In such cases it is far better to construct one large room which may be used for both purposes. A gymnasium floor should be 50 feet by 70 or 80 feet with a clear height of not less than 18 feet. To serve also as an auditorium, such a room should have a stage of generous size. When this room is used for games to which spectators are invited the stage may seat the spectators.

2. *Sample Tabulation for a School of About 200 Pupils.* — Every high school building presents its own problems. No solution for one community will apply without modification to any other community.

The following tabulation might apply to a school to accommodate 210 pupils, having a staff consisting of a principal, eight to ten teachers, including a teacher-librarian and physical training teachers devoting part of their time to other subjects, and also a clerk and a janitor.

Room	Distinctive Purposes	Supplementary Uses	Chief Equipment	Portion of Time Usable by Teacher	Pupils Accommodated in Home Rooms
1.	Gymnasium Auditorium	None	Gymnasium apparatus, removable seats	½	None
2.	Library	None	Bookshelves Display boards Magazine racks Loan desk Readers' tables for 30 pupils	Teacher-librarian	None
3.	Study hall	None	72 desks	Teachers in free periods	72
4.	Shop	None	Benches Lathes Diversified power machinery	½ to all	None
5.	Kitchen	None	Ranges Refrigerator Tables	½	None
6.	Sewing	Recitations	Tables and chairs	All	24
7.	Drawing	Recitations	Drawing desks	All	None
8.	Bookkeeping	Recitations	30 flat-top tables	All	30
9.	Typewriting	None	Typewriters	¼ to ½	None
10.	Physical-chemical laboratory	Recitations	Convertible laboratory tables Tablet-armchairs	All	None
11.	Biological-agricultural laboratory	Recitations	Plants Animals Low tables and chairs	All	24
12.	Recitations		Desks	All	30
13.	Recitations		Desks	All	30

In addition to the above rooms the following accommodations will be needed.

1. Principal's office. In the small school, supplies and text books may be conveniently kept in closets in this room.

2. Teachers' room. Designed primarily for the women teachers, this room may also be used as an emergency sick room for students.

3. Boys' coat room and toilets.

4. Girls' coat room and toilets.

5. Dressing room and showers for boys.[1]

6. Dressing room and showers for girls.[1]

7. Heating plant, including janitor's office.

8. Storage.

9. Lunch room.

It should be noted that only two regular recitation rooms are needed in the above scheme. This plan of computation is in marked contrast with the usual method of beginning with recitation rooms and adding special

[1] Under certain conditions and where geart economy is needed, it may be feasible for the boys to use this equipment on certain days and girls on other days. The better plan is to have entirely separate equipment.

rooms. The economy secured by the plan here employed is apparent.

3. *Sample Tabulation for a School of About 400 Pupils.* — In planning a building for 400 pupils, it is not necessary to utilize the principle of multiple uses as extensively as in a school to accommodate half the number of pupils.

The following tabulation might apply to a school to accommodate 418 pupils, having a staff consisting of a principal, sixteen to eighteen teachers, including a librarian and two physical training teachers who devote a part of their time to teaching other subjects, and also a clerk and a janitor.

Room	Distinctive Purposes	Supplementary Uses	Chief Equipment	Portion of Time Usable by Teacher	Pupils Accommodated in Home Rooms
1.	Auditorium	Music classes Public speaking Dramatics		½ to all	None
2.	Gymnasium	Socials		All	None
3.	Library	None	Book shelves Loan desk Display boards Magazine racks Readers' tables	Librarian	None
4.	Study hall	None	Desks	Teachers in free periods	72
5.	Shops	None	Benches Lathes Diversified power machinery	All	None
6.	Kitchen	None	Tables Ranges Refrigerators	All	None
7.	Sewing	Recitations	Tables and chairs	All	30
8.	Art	Recitations	Drawing tables Chairs	All	30
9.	Mechanical drawing	Recitations	Drawing tables Chairs	All	30
10.	Physics laboratory	Recitations	Tables Chairs	All	30
11.	Chemical laboratory	Recitations	Tables Chairs	All	None
12.	Biological-agricultural laboratory	Recitations	Plants Animals Low tables with chairs	All	30
13.	Bookkeeping	Recitations	Flat-top desks	All	40
14.	Typewriting	None	Typewriters	½ to all	None
15.	Recitations		Desks	All	36
16.	Recitations		Desks	All	30
17.	Recitations		Desks	All	30
18.	Recitations		Desks	All	30
19.	Recitations		Desks	All	30

In addition to the above rooms the same additional accommodations should be provided as were outlined for the school with 210 pupils.

The above tabulations may be suggestive as indicating a method of presenting conclusions, but should not be taken as indicating the most desirable solution for any given community. The importance of adapting a building to the needs of the community and of working out the organization of the school before making the sketch plans cannot be overestimated.

Appendix. — The following quotation from the eighty-second Annual Report of the Massachusetts Board of Education gives the recommendations of the author in his survey of the Clinton (Mass.) High School with reference to the length of recitation periods and of the school day, the limited introduction of supervised study, and special provisions for pupils who must work afternoons and evenings. These recommendations have a bearing upon the planning of high-school buildings.

A Schedule Providing for the Limited Introduction of Supervised Study. — Supervised study is now recognized as a desirable feature of secondary education. Many schools, however, find serious practical difficulties in its introduction. If the number of periods in the daily schedule is reduced there will be serious administrative difficulties, including conflicts in pupils' schedules, whereas if the school day is lengthened excessively fatigue on the part of both pupils and teachers may result. Moreover, few teachers have mastered the technique of supervised study, and there is a strong tendency on their part to keep the pupils reciting for the entire period, thus defeating the purposes for which the periods were lengthened. In order to avoid these pitfalls and to meet certain other conditions, the following recommendations were made with regard to the daily schedule:

At the present time the high school day begins at 8.15 and closes at 1.05. Five minutes are devoted to opening exercises. There are six forty-minute periods, with five minutes for change of classes between the first and second periods, the third and fourth periods, and the fifth and sixth periods, and two fifteen-minute recesses between the second and third, and fourth and fifth periods.

I am told that the majority of the families in Clinton have their heartiest meal at noon. In view of the fact that pupils are unable to reach home until after 1 o'clock they cannot eat this meal with the family. Either the householders must keep the dinner warm until the arrival of the high school pupils, or else these pupils must have a cold dinner. This undoubtedly results in undernourishment for a large proportion of the pupils at an age when adequate nourishment is a matter of great importance. Furthermore, the town of Clinton is so small in area and the high school is so centrally located that it would be possible for all pupils who live in the town to go home for their dinner if the noon period were made about an hour and a quarter in length. Consequently, I recommend the adoption of a two-session plan, the morning session extending from 8.10 to 12, and the afternoon session beginning at 1.15.

The present tendency is strongly in favor of a longer school day in order that pupils may be able to do a larger part of their studying at the school, where materials for school work are at hand and where they may have the help and guidance of the teachers. High school pupils need to be taught how to study. Without such instruction they are unable to work to the best advantage. This is one of the chief causes for discouragement and the dropping out of school. To offset this difficulty "supervised study" is being introduced into many high schools. According to this plan the recitation period is lengthened to sixty or seventy minutes so as to include time for recitation and time for study under the direction of the teacher.

However, if all six periods were lengthened to sixty or seventy

minutes, it would make a school day much longer than the present high school day at Clinton. I am, therefore, recommending that three of the six periods be lengthened to sixty-five minutes each, including time for change of classes; that the other three periods be only forty minutes in length, including time for change of classes; and that these periods be so arranged that every class which has five recitations a week will have two or three sixty-five minute periods and three or two forty-minute periods.

I am also recommending that fifteen minutes be devoted each day to setting-up exercises. These exercises are being conducted in many schools, and are growing in favor. They do not take the place of vigorous gymnasium exercises, but give relaxation, increase the circulation, and prevent fatigue. I am suggesting that they come after the second period, where they will be most useful in checking the fatigue element.

The lengthening of the school day here recommended is in harmony with the present tendency throughout the United States.

SCHEDULE RECOMMENDED

8.10 to 8.15, opening exercises.
8.15 to 9.20, long period No. 1.
9.20 to 10.25, long period No. 2.
10.25 to 10.40, setting-up exercises.
10.40 to 11.20, short period No. 3.
11.20 to 12, short period No. 4.
Noon intermission.
1.15 to 1.55, short period No. 5.
1.55 to 3, long period No. 6.

In order that each subject may share in the longer periods I should recommend that the thirty periods in the week be divided into six nonconflicting groups designated as A, B, C, D, E, F; that the four morning periods, A, B, C, D, occur in alphabetical order on Monday, Wednesday, and Friday, and in reverse order on Tuesday and Thursday; and that the two afternoon periods, E and F, occur in alphabetical order on Monday, Wednesday, and Friday, and in reverse order on Tuesday and Thursday. A subject assigned to the A, B, or E periods would, therefore, have three long periods and two short periods, while a subject assigned to the C, D, or F periods would have two long periods and three short periods.

PERIOD	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
Morning					
1	A	D	A	D	A
2	B	C	B	C	B
3	C	B	C	B	C
4	D	A	D	A	D
Afternoon					
5	E	F	E	F	E
6	F	E	F	E	F

This schedule provides for supervised study. It allows sufficient time for laboratory work in the sciences without the necessity of scheduling so-called double periods for this purpose. Furthermore, it makes possible effective work in physical training. Pupils cannot obtain the kind of physical training that they need unless they have time in which to put on gymnasium suits, to take vigorous exercises, and to follow the exercise with the shower bath. The sixty-five minute period gives sufficient time for this purpose. The third and fourth periods separately would be too short, but combined as a double period they would give eighty minutes for physical training. The other short period, namely, the fifth period, should not be used for gymnasium work, as it comes too soon after dinner.

As a slight modification of the above schedule, the two long periods on Friday morning could be shortened to provide for an assembly period. Even then every subject coming daily would have two long periods each week.

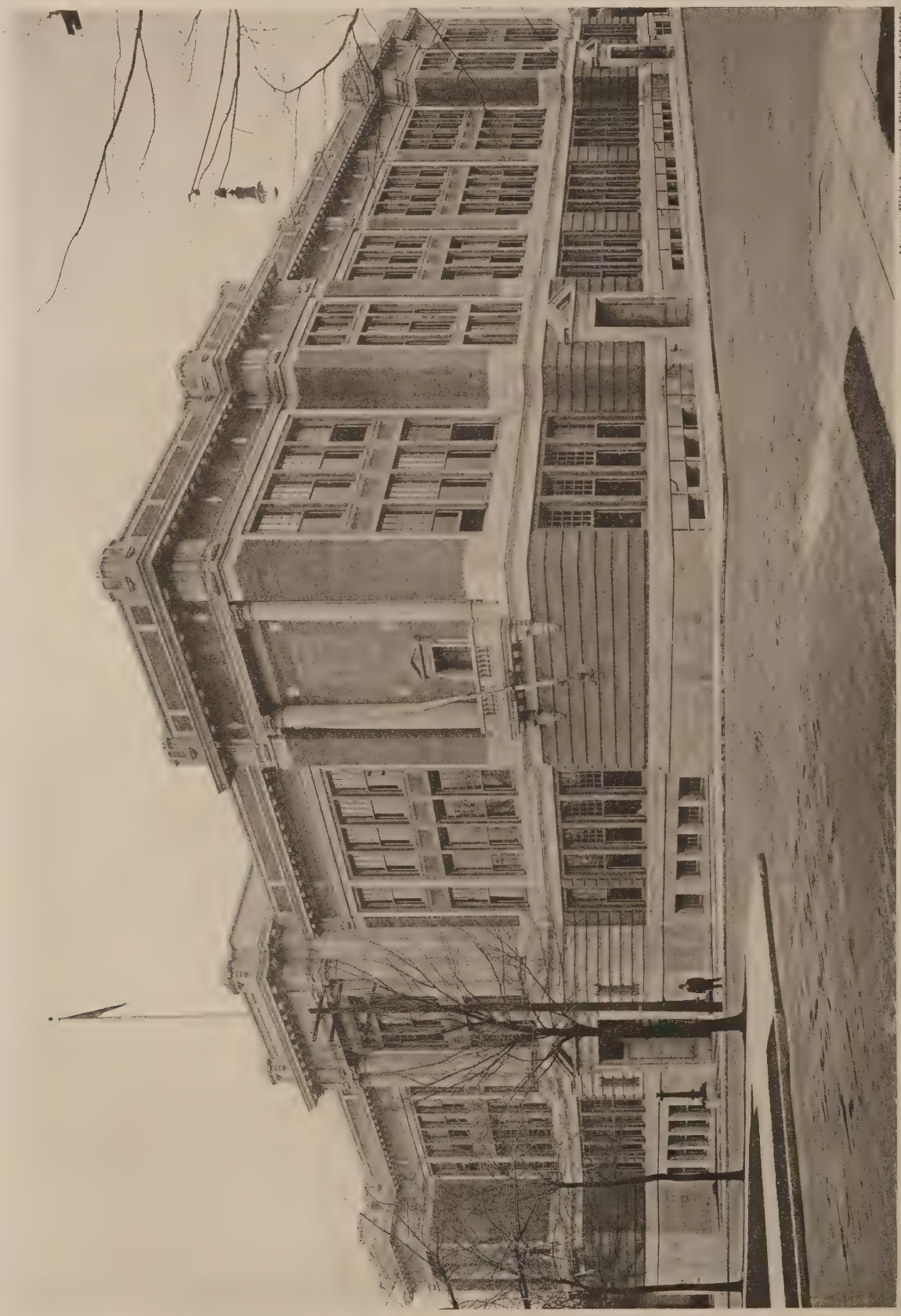
Special Provision for Pupils Who Must Work Afternoons and Evenings. — In many high schools the most serious objection to supervised study and the longer school day is due to the fact that many pupils must, or think they must, earn money while attending school. For such schools the following plan, recommended for Clinton, may be suggestive:

A very large proportion of the pupils in the Clinton high school are working afternoons, or evenings, or both, as may be seen from the following table:

PUPILS WORKING AFTERNOONS, OR EVENINGS, OR BOTH

	FRESHMEN	SOPHOMORES	JUNIORS	SENIORS	TOTALS
Boys.					
Attendance	28	22	13	18	81
Working	16	18	11	18	63
Per cent working	57	82	85	100	78
Girls					
Attendance	44	29	28	29	130
Working	5	7	6	17	35
Per cent working	11	24	21	59	27
Totals					
Attendance	72	51	41	47	211
Working	21	25	17	35	98
Per cent working	29	49	41	74	46

For pupils who must earn a part or all of their support in order to continue in school, some adjustment should be made in the distribution of their time and energy. If they attempt to carry the full amount of school work, either the quality of that work is likely to deteriorate, or there is likely to be a serious drain upon health and vitality. The superintendent of schools and the acting high school principal assure me that they have observed a deterioration in the quality of the work of these pupils. On the other hand, it would be unfair to pupils devoting their entire time to school work to reduce the amount of work that they may do to the amount that can be carried successfully by the other pupils. The schedule recommended above is so arranged that certain subjects come entirely in the morning and others entirely in the afternoon. Therefore, a pupil who must work in the afternoon can carry in the morning as much work as he can do successfully. As a rule, it would be wiser for these pupils to undertake each year three-quarters of the full amount of high school work and maintain a good standard of scholarship, rather than attempt the full amount of work and either fail in part of it or do work of an inferior quality. There is little educational value in inferior work. With this plan they may complete the high school course in five years without sacrificing the quality of their work. With the elimination of the ninth grade these pupils will complete the elementary and high school work in thirteen years, the time hereto-



Messrs. Whitehouse and Foulhoux, Architects.

FIG. 126. — LINCOLN HIGH SCHOOL, PORTLAND, OREGON.

fore required of all pupils. On the other hand, the pupil who can devote all his time to school work may complete the course in twelve years.

It may be observed also that the proposed schedule permits the pupils who must work afternoons to obtain a hot dinner at the regular time instead of hurrying home at 1 o'clock, eating a cold lunch, and then hurrying to work. Adequate nourishment is certainly of prime importance to these young persons who are both studying and working.

In order that pupils who work afternoons may not be deprived of any subjects offered by the school, it is recommended that subjects given only in the afternoon in one year be placed in the morning the next year.

As explained later in this report, a pupil who is obliged to work afternoons the last year or the last two years only may, if he maintains a good record in the earlier years, be able to graduate in four years.

The adoption of the above plan actually resulted in attendance for the full school day on the part of all but a very few pupils. In other words, when pupils found that they could carry only part of their work on a single session plan they decided to attend both morning and afternoon.

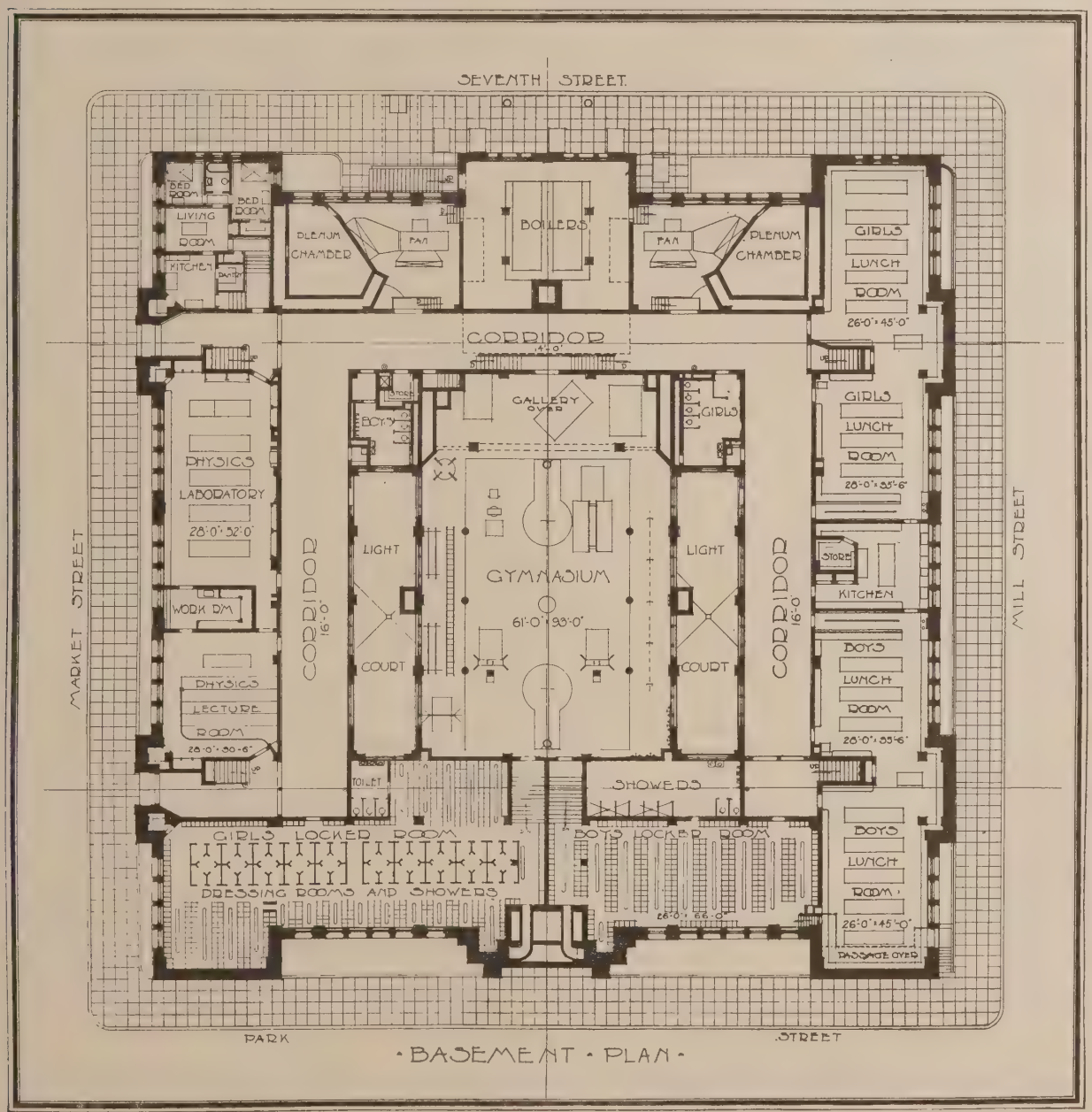


FIG. 127. — LINCOLN HIGH SCHOOL, PORTLAND, OREGON. *Messrs. Whitehouse and Foulhoux, Architects.*

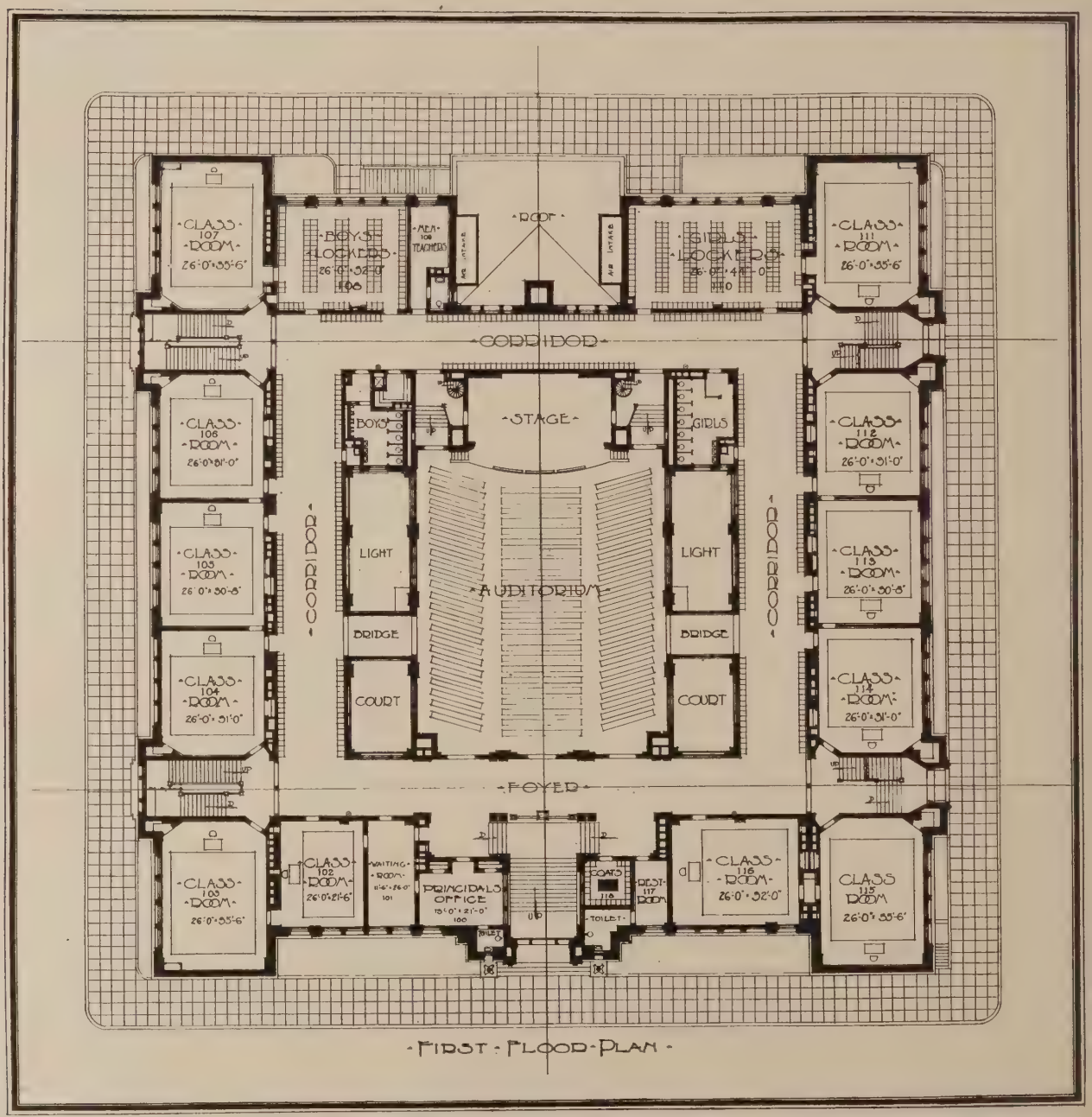


FIG. 128. — LINCOLN HIGH SCHOOL, PORTLAND, OREGON. *Messrs. Whitehouse and Foulhoux, Architects.*

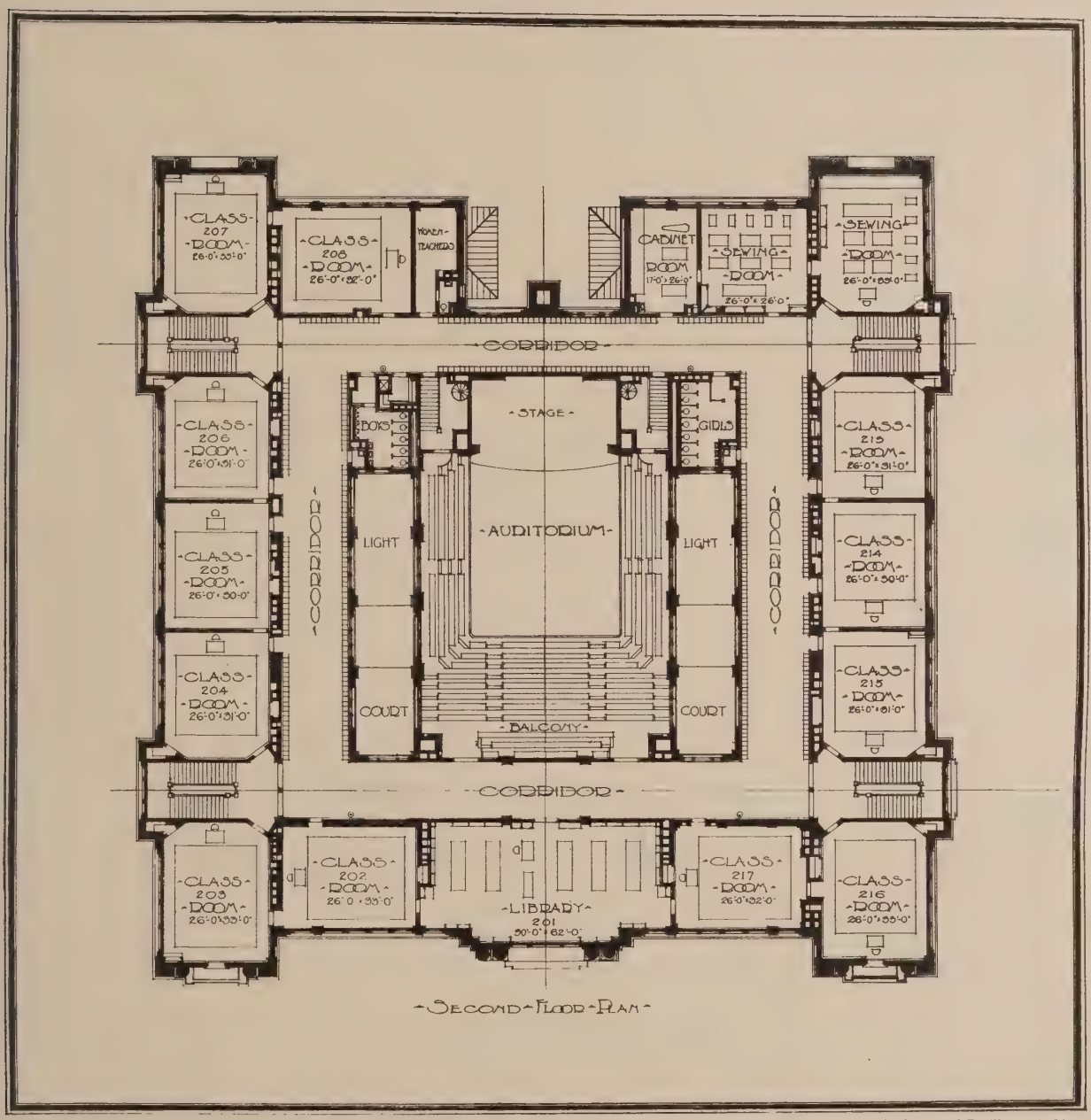


FIG. 129. — LINCOLN HIGH SCHOOL, PORTLAND, OREGON. *Messrs. Whitehouse and Foulhoux, Architects.*

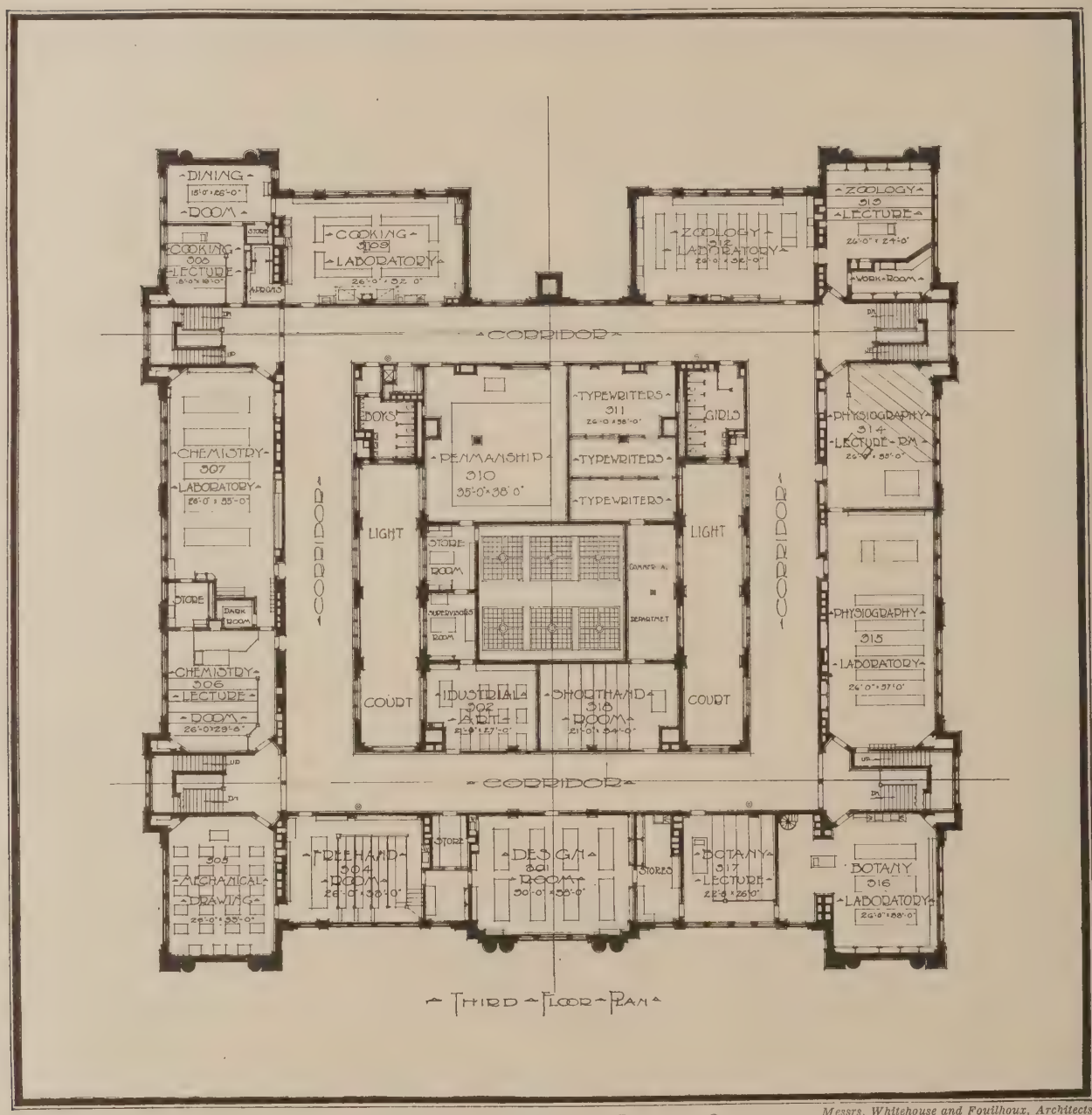


FIG. 130. — LINCOLN HIGH SCHOOL, PORTLAND, OREGON.

Messrs. Whitehouse and Foulhoux, Architects.

CHAPTER VIII

BUILDINGS AND EQUIPMENT FOR VOCATIONAL SCHOOLS

By J. D. Wright, *Acting Assistant Director for Industrial Education, Federal Board for Vocational Education*

I. General Education and Vocational Education. 1. Types of Vocational Schools or Classes. 2. Function of the Vocational School. 3. Agencies Promoting Vocational Education.

II. Trade and Industrial Schools or Classes. 1. Industrial School Buildings versus General School Buildings. 2. Types of Schools and Buildings: (1) Types of Schools; (2) Types of Buildings in General Use. 3. The Problem of Equipment: (1) Type Equipment; (2) What Kind of Tools Should Be Provided; (3) The General Industrial School; (4) Obligation of the Local Community. 4. New Building for Trade or Industrial Education: (1) Location; (2) Construction; (3) The Factory Type of Industrial School; (4) Division of the Interior; (5) Kinds of Rooms and Relative Floor Space; (6) Replies to Questionnaire. 5. Building and Equipment for a Trade or Industrial School: (1) The General Plan; (2) A Typical Shop; (3) General Specifications; (4) Machine Shop; (5) Carpentry and Cabinetmaking; (6) Electrical; (7) Printing; (8) House Painting and Decorating; (9) Sheet Metal; (10) Plumbing; (11) Pattern Making; (12) Related Subjects; (13) The General School; (14) Old Buildings, Factories, or Industrial Plants as Temporary Quarters; (15) The Part-time School; (16) The Evening Industrial School. 6. A Few Type Buildings: (1) The Worcester Boys' Trade School; (2) The David Ranken, Jr., School of Mechanical Trades; (3) The Williamson Free School of Mechanical Trades; (4) The Lathrop School of Mechanical Trades; (5) The William Hood Dunwoody Industrial Institute; (6) Milwaukee Boys' Technical High School; (7) The New Bedford Vocational School; (8) The Bayonne Vocational School; (9) The Wentworth Institute; (10) The Pullman Free School; (11) The Boys' Vocational School. 7. Trade and Industrial Schools for Girls: (1) Manhattan Trade School; (2) Milwaukee Public School of Trades for Girls; (3) Worcester, Mass., Girls' Trade School; (4) Jane Hayes Gates Institute.

III. Buildings and Equipment. 1. Types of Schools. 2. Types of Buildings: (1) Smith Agricultural School; (2) Plan of Combination Laboratory and Recitation Room; (3) Shop Building, Sterling, Colo.; (4) A Combination Shop Suggested.

IV. Home Economics. 1. The Purpose of Vocational Home Economics Schools: (1) Home-making Activities. 2. Schools Teaching Home Economics: (1) Day Schools; (2) Part-time Schools; (3) Evening Schools. 3. Types of All-day Schools: (1) Separate Schools of Home-making; (2) Home-making Departments of Trade Schools; (3) Home-making Departments of Elementary and Secondary Schools. 4. Modifications of Equipment: (1) In a High School; (2) Essential Points; (3) The Practice House; (4) Cafeterias and Lunch Rooms. 5. Standards in the Selection and Equipment of Rooms for Home Economics Instruction: (1) Location; (2) Size; (3) Lighting; (4) Ventilation; (5) Wall Finishes.

I. General Education and Vocational Education

General Education and Vocational Education. — School architects and school administrators are often called upon to assume the responsibility for the design of new buildings. Modern school buildings are no longer thought of in terms of a single classroom. Problems of construction in heating, lighting, ventilation, and sanitation have all become secondary to the larger problem of *adaptability*. What educational function is the building to serve? What are the needs of this phase of education for which the architect must make provision in his plans and specifications? To answer these questions a general knowledge of the kinds of education and a distinction between their functions would seem to be necessary.

General Education, properly directed and controlled, aims to improve general intelligence. *Vocational education*, on the other hand, aims to make an intelligent producer, either of commodities or of services. The aims of elementary and high schools include many motives which are not germain to vocational training.

Many high schools have as a definite aim the preparation for entrance to higher institutions of a large number of pupils who are at least potential candidates for entrance into such institutions. Education and training of this character does not primarily concern itself, as does vocational education, with the preparation of youth for immediate self-support in a determined-upon occupation.

In a sense it is true that all education, provided the educative process is well planned and well executed, is preparation for citizenship and for vocational activities, but it should be clear that the dominant aims of a person or group of persons at any given time should determine the content and the method of the appropriate educational process.

When an individual starts upon his life work, either by definite preparation for a particular vocation or by actual participation in the work of that vocation, his

interest in studies possessing exclusively a general or interpretative value is eclipsed by the immediate focusing of his attention and by the concentration of his efforts upon vocational interests.

Except in the case of a few professions, such as law, theology, and medicine, until comparatively recent times, men have learned vocations by entering upon them. During the last century, however, there has been a rapid growth of vocational schools of many kinds, such as normal schools, dental colleges, pharmaceutical schools, training schools for nurses, engineering schools, agricultural schools, and business schools. As society has developed needs for the services of persons trained in special vocations, schools, either private or public, have been established to prepare persons who have chosen for a life work, service in particular vocational fields. Vocational schools have not been organized, however, until the vocations themselves have developed a content, technique, or method to such an extent that adequate preparation could no longer be given by apprenticeship or shop-training methods.

It must be assumed as axiomatic that vocational education is intended and provided for individuals who have made definite vocational choices, and for such individuals only.

A clear understanding that this determination of aim is an essential prerequisite to effective vocational training of an individual would clear up much confusion which now exists as a result of the use of the term "vocational" to describe certain subjects of study in the general elementary or secondary school, such as manual training or mechanical drawing and shopwork, which are pursued by those who probably have not yet selected a vocation. While the educational value of these and other "practical" subjects is not questioned, there rests clearly upon the school and the community an obligation to set up adequate means to help the pupil and his parents to determine wisely upon specific vocational preparation.

Types of Vocational Schools or Classes. — Vocational education is for two distinct groups of students. Boys and girls enrolled in public schools *who are preparing to enter a particular occupation* may be given instruction in all-day vocational schools; and *workers who have already entered upon employment* may be given vocational training in part-time and evening schools.

The public cosmopolitan high school can, under favorable conditions, undertake courses of one to four years, provided a separate department for the vocational courses is created, and provided such courses are supported by a sufficiently broad conception of community needs on the part of those charged with this sort of secondary education. Such a high school will assume its full responsibility if the vocational courses meet two sorts of community needs: first, those of the youth in that community who will seek employment before or at completion of the high school course, and, secondly, those of the industries of that community for greater efficiency in their labor force.

Schools for workers are of two types. First, those for persons who are employed under such conditions that they can give a part of the regular hours of employment to educational work, and secondly, those for persons who must secure their further education, if at all, outside regular working hours. The former are *part-time* schools, the latter *evening* schools.

Function of the Vocational School. — While vocational schools are in general organized to fit the individual for profitable employment, they are specifically directed towards assisting two types of individuals; first, *those who are preparing to enter employment;* second, *those who are already employed.*

To prepare young men and women for employment we must have *special schools* or *departments* with an extensive equipment and buildings. These must approach as near as possible the actual conditions of the industry, the home, or the farm.

In the trades and industries, the responsibility for training workers has been rapidly shifting from the industry itself to other agencies both public and private. This change has been, in a large measure, the direct result of industrial development and in the interest of more technical skill on the part of the worker.

The large number and variety of industrial occupations for which training may be given presents a much larger problem in the erection of buildings, and purchase of equipment, than exists in the organization of other kinds of vocational schools. As a result of this condition, *trade* and *industrial* schools have too often confined their activities to certain typical occupations such as the building trades, the metal trades, and printing trades, while those special industries in which a very large part of the population of the community is engaged, such as textile mills, mining, or manufacturing, are neglected. To meet the vocational needs of the community, the school must possess buildings and equipment which will bring the pupil into close contact with trade conditions.

When well organized and equipped with machinery and laboratory facilities and supplied with qualified teachers, the school should enable the pupil to secure an advantageous entrance into industry.

Home economics schools are intended to prepare girls for useful employment as home makers and house daughters engaged in the occupations of the home. The organization of these schools is much more simple

in its requirements in the selection of equipment and the design of suitable buildings or departments.

In vocational *agriculture* the school must be prepared to give the boys a practical experience in farming. It must therefore have farm lands, farm animals, farm machinery, and a laboratory in which to conduct farm experiments.

Agencies Promoting Vocational Education. — It might be assumed that the responsibility rests upon the individual to provide his or her own educational opportunities, or upon the family for the education of the children. In our social progress we have long recognized the individual as a member of society, a part of the community, and one whose efficiency not only determines his own position in life but one who, together with many others, determines the success of the whole community, the state, and nation.

The community as an entity depends upon the prosperity and intelligence of its citizenship. Industry demands a supply of skilled workers as well as materials. These workers must be provided if new business is to be secured. The individual has grown to look to the local government for his elementary and secondary education.

On the other hand, states have recognized that their wealth and prosperity are dependent upon the communities within their borders, and that many workers are migratory, and that it is therefore necessary for the state to provide uniform educational facilities.

No less than either of these is the responsibility of the Federal government for the development of our natural resources in farm lands and minerals, and for the improvement in methods of operation in production, in manufacture, in transportation, and in selling our products in the markets of the world.

The communities have for many years given to the people full opportunities for general education. It has even made attendance compulsory in some states to the age of sixteen.

Previous to the passage of the Smith-Hughes Act for vocational schools, several states had enacted laws giving state aid to the communities in the payment of a part of the cost of vocational education. The Federal Act does not provide for the organization of schools direct, but does make provision for giving aid to the states and local communities in the payment of a part of the salaries of approved teachers in these schools.

This aid is given under certain general conditions of approval:

1. All schools receiving Federal aid must be under public supervision and control.
2. The controlling purpose must be to fit for useful employment.
3. The instruction must be of less than college grade.
4. The instruction must be designed to meet the needs of persons over 14 who have entered upon or who are preparing to enter upon a vocation.
5. Every dollar of Federal funds must be matched by a dollar of state or local funds, or both.
6. Reimbursement for the salaries of teachers will be made to schools only for those teachers who meet the qualifications set up in the state plan as approved by the Federal Board.
7. That the state or local community, or both, shall provide the necessary *plant* and *equipment* determined upon by the state board, with the approval of the Federal Board for Vocational Education.

II. Trade and Industrial Schools or Classes

Industrial School Buildings vs. General School Buildings. *Comparative Floor Space Required.* — Standards for general school buildings require fifteen to twenty-four square feet of floor space, and two hundred to two hundred and fifty cubic feet of air space per pupil in the classroom.

These values are based upon many years of experience with the general school. The usual classroom is approximately 22 by 32 feet and accommodates 45 pupils. This space is inadequate for industrial shop classes. During the past 20 years manual training has come into the course of study as a supplementary type of general education, with one to three hours per week in the upper grades of the elementary schools and three to five per week in the high school. It is not possible to give in these classes more than general principles and to lead the pupil to an appreciation of industrial problems. Conclusions based on experience in manual training schools do not furnish an adequate basis for determining the amount of floor space needed in trade and industrial schools.

Floor Space in Existing Schools. — In elementary schools manual training shops have usually been placed in class or basement rooms, many of which are small and possess poor light, heat, and ventilation. In high schools architects usually make more adequate provision for shops than in elementary schools.

The following table shows the floor space given to different shops in several existing cosmopolitan high, technical high, and trade schools.

School	Square Feet of Floor Space						
	Woodworking Shop	Woodturning	Forging	Machine Shop	Electrical	Masonry	Pattern Shop
Soldan High, St. Louis, Mo.	2,180	2,440	1,800	2,070			
Northeast High, Kansas City, Mo.	1,794	1,716	1,056	1,716			
David Ranken, Jr., School of M. T., St. Louis, Mo.	4,324		Plumbing 4,312	5,170	2,450	2,450	2,116
Milwaukee Trade School, Milwaukee, Wis.	5,336		5,336	5,336	5,336		5,336

Need for Industrial School Buildings. — The rapid growth of industrial schools is a development of the educational system designed to meet the demand in the industries for more skilled workmen, foremen, and superintendents.

The situation is rapidly becoming serious and must be met by a system of industrial training which will supply the ever-increasing demands of industry for intelligent man power. To meet this demand, trade and industrial schools are needed. Pupils must be given such experience and trade training as will fit them to enter successfully upon industrial employment. This new education requires a new type of school building.

Types of Schools and Buildings. *Types of Schools.* — The Federal and State acts provide for all-day, part-time, and evening vocational schools. Buildings which meet the needs of the all-day school will usually be satisfactory for part-time and evening classes. Where part-time classes are organized for general education, the ordinary classroom will be suitable. Since trade extension and related subjects are usually given in the part-time or evening school, it is desirable to provide facilities for these subjects in all new or remodeled buildings.

Types of Buildings in General Use. — The trade or industrial training may be given in a separate school or in a separate department of a general school. Where the work is given in a separate school, three kinds of plants are to be found in this country: The special building erected for the purpose, usually by an issue of bonds; the old factory building remodeled for the purpose; and the abandoned schoolhouse which has outlived its usefulness for general education and is remodeled to serve temporarily for industrial training.

The Special School Building. — Such schools as the Williamson Trade School near Philadelphia, the Wentworth Institute at Boston, the William Hood Dunwoody Institute at Minneapolis, which are private schools; and the Worcester (Mass.) Trade School for Boys, and the Milwaukee Trade School for Boys, which are publicly supported, are quartered in *special buildings built for the purpose.*

This seems to be a wise and safe course to pursue in cases where the local authorities are certain that they know just what kind of a building is needed to meet the local situation. It insures proper conditions for doing the work from the start. There is danger that the building will not meet the changing conception of the service which the school should give its pupils. Experience seems to show that where a special building is erected as a *general trade school* for giving industrial education, it is advisable to build on a unit basis, each unit being devoted to one or more trades, and new units being added from time to time to meet the needs of the school.

In some cities the tendency is toward a *unit trade school* for printing, for machinists, for textile workers, and for other trades for which the local community needs skilled men or women.

Converted Buildings. — The New Bedford and Springfield, Mass., independent industrial schools, and the Industrial School at Rochester, N. Y., occupy old factory buildings which have been remodeled so as to provide for a time at least fairly adequate accommodations for the school. This method of housing the work can be resorted to successfully in communities where funds are not available to provide a special building, or when the school authorities have not determined upon the kind of a plant required to meet their changing ideas of what the school should do.

The *old factory building*, however, is often poorly adapted to school purposes. Sometimes the location is bad; usually the lighting poor and the heating arrangements inadequate. Such a building should properly be regarded as a makeshift or device to be used for a brief period as the first step in the introduction of industrial education in the community.

Many cities have found it advantageous to organize their first industrial schools in old schoolhouses which have been remodeled. This method of introducing industrial education is good when the community is carrying on a small experiment or beginning the work. By beginning in this way, school authorities are able to find out what should be done on a large scale in the case of each kind of trade training. Further, an opportunity is thus given to prove the worth of the work before larger public funds are asked for.

Abandoned schoolhouses are seldom adapted to vocational work. The lighting is usually poor; the rooms are not the right shape and size; and the construction of the building is not adapted to the installation and use of machinery.

Some states are attempting to solve the problem of industrial education by utilizing *separate departments in general high schools.* While the children in the department of vocational education might well participate in the social activities of the school, the best results will be secured when their training is given in a distinct unit of the building, erected or set apart for this purpose. The difference in the character of the work which they are carrying on requires such a separation for most of the day.

Whenever plans are being made which provide for a department of vocational education in a general school building, the same care should be given to the con-

struction and equipment as in the case of a special school. As near as possible the shops should be located on the ground floor and away from classrooms. A separate outside wing will enable the architect to provide necessary facilities better than an inside room.

The Problem of Equipment. *Type Equipment.* — How much equipment is needed? If the pupil is to be adjusted to meet the demands of industry, his training must be real. To be real, the training must be given in a shop making things on a useful or productive basis. Schools giving training in such subjects as woodworking, metal working, electrical work, etc., can readily find use for the work of the pupils either in the building itself or in the school system. Every school should make a part of its own equipment. This has been done by most of the industrial and trade schools. Enough equipment ought to be bought at the outset to start the work and to enable the school to operate on a productive basis.

Where schools find themselves with limited resources at the start, some second-hand equipment for use in the first year of the course can be bought. In the other years of the course it is necessary to secure the very latest and best machinery, so that when the boy leaves the school he will be familiar with the latest equipment and able to take his place in industry.

One of the handicaps under which the school shop must always labor is that of keeping its machinery fully abreast of the best equipment of the commercial shop. It is doubtful whether this can ever be done successfully. Under the stress of competition, the commercial shop changes its equipment from time to time. Without such competition the school is very likely to remain content with machinery that is out of date.

This is one of the strongest reasons why the part-time scheme of education which enables a boy to obtain the most of his practical training in the industry itself promises to be effective in dealing with the great body of wage earners between 14 and 18 years of age. The old trades, in which men were able to obtain experience with all the different tools, machines, and processes of their callings, are rapidly disappearing. Modern industry does not give the worker a chance to get a broad experience in working with different machines. The typical boy who comes to the part-time school is one who is spending his entire time at one machine, making one small part or portion of the final output of the factory.

The school must always take the boy as it finds him and give to him the training he needs. In giving part-time instruction to the worker at the specialized machine, the school, if it is to meet modern industrial conditions, must under the school roof provide a sufficient amount of equipment to enable the boy to acquire the elementary practice and experience at the machines and with the tools and in the processes which the shop denies him and which are necessary to his insight, interest, and growth in the occupation. All experience goes to show also that a minimum amount of the equipment must necessarily be under the school roof in order that the teacher may closely correlate and connect the instruction which he is giving with the shop processes.

What Kind of Tools Should Be Provided. — One great mistake which many manual training and technical high schools have made, and which industrial schools are in danger of making, is that of providing a large number of tools and machines of one kind rather than a smaller number of different tools and machines. The same amount of money put into a more varied equipment would enable the school, whether it be a manual training school or trade school, to deal with pupils individually, so as to give each a wider range of experience with different machines, to substitute the individual for the group method of instruction, and to approximate more nearly the conditions of real shopwork so necessary in the successful training of skilled workers in industry.

The General Industrial School. — The Federal Vocational act provides that for cities of less than 25,000 population the state board, with the approval of the Federal Board, may modify the conditions as to length of course and hours of instruction per week.

In making such modifications, the number of hours of instruction per week must in no case be less than 25, or the number of hours of instruction per day less than 5, a total of 300 minutes. Where no large employing industry exists in these cities general industrial schools may be organized. This type of school gives to the pupil a general training in industrial subjects. One-half of the five-hour day must be given to shopwork on a useful and productive basis.

This is the only type of industrial school which seems feasible in cities of this size, because in most cases there is not enough demand on the part of any industry for new employees to justify unit trade training, as in the case of an all-day trade school, where a boy spends all of his time training as a machinist, carpenter, plumber, or printer. In the general industrial school, the idea is to fit the boy with some experience in shopwork in several typical trades, such as carpentry, electrical work, automobile work, and in connection with this shopwork to give him instruction in related drawing, science, and mathematics, and in such nonvocational subjects as are needed for a well-rounded course of instruction.

To carry out this scheme the school shop, instead of

having a carpenter shop filled with carpenter benches and a printing shop full of printer's cases, would be equipped with the small number of tools and machines necessary to give, in an elementary way, experiences in several different occupations.

Obligation of the Local Community. — In establishing a trade or industrial school, department, or class, the state or local community must assume the responsibility of providing the necessary plant and equipment. This must be adequate to meet the needs of the class for the trade to be taught.

Where schools are approved for state and Federal aid in payment of the salaries of teachers of vocational subjects, the local community should be able to supply adequate buildings and equipment.

New Building for Trade or Industrial Education. *Location.* — In locating a new trade or industrial school, care should be taken to locate the plant on a site sufficiently large to provide for additional units needed to meet the growth of the school. The site should be chosen so as to accommodate the entire city from the standpoint of street car and other facilities. Experience shows that industrial schools can coöperate with industry to a greater advantage when the school is situated near an industrial center. This, however, does not warrant locating vocational schools in districts where the social and sanitary conditions are undesirable.

In the preparation of bulletin No. 20 for the Federal Board for Vocational Education, a questionnaire was sent to nine industrial or trade schools of different types asking, among other things, for an opinion as to " what factors should determine the selection of a site for a new trade or industrial school? " The replies of the schools are given in separate paragraphs below.

"Avoid crowded space. The plant should be far removed from saloons, pool halls, and other things that tend to distract pupils. The school should be accessible to its pupils. This is particularly desirable for evening school instruction to day workers. A spur track is desirable."

"Avoid dangerous influences, questionable neighborhoods, etc. Locate site near good car lines. Have ample space for recreation and future additions. Give the school as fortunate surroundings as would be given to any other school."

"Accessibility for majority of pupils who would attend. Near business center. Proximity to factories or industrial center is not important factor. Should have as much dignity as a high school site."

"Kind of trades to be taught — manufacturing or building. If the school is coöperative, locate near industrial plants; if all-day school, this factor need not be considered."

"Should be accessible to street cars. Away from factories using soft coal. Away from tenements where many children are in the street. Adjacent to business section. Accessible to customers and pupils. Site should be large enough for outdoor activities."

"If possible, avoid noisy factory districts. Within one block of transportation. Lot to have room for recreation, light, ventilation. The residential district of the pupils."

"Good car service. Facilities for coöperating with industries. Character of the neighborhood should be such as to bring the pupils into contact with no undesirable influences. Grounds should be large so as to accommodate the school for the present and future, and give light, ventilation, and space for recreation."

"Avoid a noisy, sooty, squalid district. The site should be accessible and near manufacturing plants. Good environment and located so as to come within the general notice of the public."

"Good car service. Large area to allow for good athletic field and for expansion. In industrial center."

Construction. — It is not the writer's intention to set up plans and specifications for the construction of buildings which may be used for trade or industrial schools, but rather to call the attention of architects and school administrators to some conditions which increase the efficiency of the plant and equipment.

Many states have laws regulating the construction of factories and public school buildings. These regulations should be observed in connection with the local building code.

Architects and school authorities should study the characteristics of the modern trade school, and incorporate in the design of proposed buildings such requirements as have been found necessary to meet the demands of trade training. In planning a new building, the architect should provide shop-floor space of from 100 to 300 square feet per pupil, depending upon the particular kind of industrial work for which the shop is to be used. In shops requiring the installation of woodworking or metal-working machinery, a larger floor space must be available. Ceilings should be constructed varying from 12 to 32 feet in height. Rooms for class recitation, mechanical drawing and laboratories should provide a floor space of from 25 to 90 square feet per pupil. In planning a new school building, care should be taken to provide for adequate tool and stock rooms in which to store all of the general tools and stock used for instruction in the shop. Tool and stock rooms should be provided with shelving and lockers suited to the needs of the particular industry for which the shop is used. As a part of their course in any trade pupils should be given instruction in the care of the tool and stock rooms, so that they may be taught to preserve and care for their own tools and equipment. A detailed description of shops for various trades will be given later in this chapter.

The Factory Type of Industrial School. — The construction of the factory type must be of such a character as to provide a large amount of light. Extra light may be obtained in one-story buildings by means of northern sawtoothed skylights, and thus avoid the glare of the direct sunlight. Windows should be planned to occupy as much of the exterior wall space

as the construction and architecture of the building will permit. It is desirable that the windows be of factory construction with small panes, so that accidental breakage will not cause large expense for replacement. In the construction of the floors, a knowledge of the purpose for which the room is to be used is necessary.

Each individual trade should be considered from the standpoint of its needs under commercial conditions, and the plan made to provide necessary floor space, light, door openings for admission of large work, and freight elevator service.

Architects should not specify cement floors for shops in which edged tools are to be used, as it is impossible to avoid dropping tools on the floor. Whenever possible, wooden floors are preferable in such cases. Floors in which heavy machinery is to be installed should be designed to sustain the floor load weight with a sufficient safety factor to support future additions to the equipment. It is not always necessary or desirable to plaster interior walls. Machinery and fixtures are much more easily adjusted in shops where the walls are left with a brick finish. The roof construction, like the floors, necessitates on the part of the architect a knowledge of the purpose for which the room is to be used. Provisions should be made for numerous inserts in the ceiling and for suspending shaft hangers from steel girders whenever metal-working machinery is to be installed.

Ample locker space, wash and toilet rooms should be provided. The requirements for sanitation should be carefully observed. In planning the wash and toilet rooms of the new buildings, a careful study should be made of the flushing systems, and the location should be convenient to the shop rooms. It is not desirable to place wash rooms or toilets in basements where the problems of sanitation are greatly increased.

The power plant installed in a new building offers an opportunity for giving courses in power-plant operating in steam and electricity, and therefore should be installed with these courses in mind. The engine room should be large and well lighted, and in most cases should be located so as to be convenient to the electrical department. This will permit the use of the generators, motors, and the switchboard for testing purposes in power-plant operating.

Schools engaged in project work will often find it necessary in the construction of certain projects to utilize several shops for the different kinds of work involved. When the building is planned, the shops should therefore be located with these conditions in mind, so that the least amount of confusion will result in moving projects from one shop to another.

It is recognized that the amount of light required per square foot in industrial plants is usually larger than in other buildings. Schools located in northern latitudes require more glass surface for natural light than do those located in central or southern latitudes. The wiring for electric lights should be calculated so as to provide for additional service when needed. Switchboards should be located in the room and fitted with a lock and key as a protection to the machinery. Whenever possible all wiring should be in conduit. Main conduit leads should be made oversize so as to permit drawing an extra pair of service wires if needed for future equipment.

All machines should be supplied with floor or wall outlets for drop-lights and fitted with safety appliances to meet the requirements of the state factory laws.

In the same way that modern architecture provides for the location of furniture in modern homes, the construction of a new building for teaching trades should provide for the installation of the equipment. Woodworking machinery should be arranged for efficient service in routing the material through the machines. All machines making smoke, sawdust, or shavings should be connected to an exhaust system.

Division of the Interior. Temporary or Movable Partitions. — Trade and industrial education is comparatively new in this country. It is growing very rapidly through a series of developmental stages, and no one is able to forecast accurately what the needs of any one institution will be a few years from now. *Permanent interior bearing* walls should be avoided as a means of providing greater flexibility in adjusting interior partitions to the needs of changing conditions in the shops and classrooms.

Kinds of Rooms and Relative Floor Space. — Whatever type of building may be selected, the interior will be divided into rooms for shopwork, science, drafting, classrooms, and rooms for administrative purposes.

The Federal and state acts require that a specified time shall be devoted in day schools to practical work. In addition, sufficient time for proper teaching must be given to instruction in related or technical subjects which are also vocational. The remaining time should be given to non-vocational subjects "necessary to build well-rounded courses of instruction."

Experience in vocational education in trades and industries gained by this country during the last 10 years has established the following as the prevailing practice:

(*a*) In day industrial or trade schools, at least one-half the time is given to practical work on a useful or productive basis.

(*b*) From 25 to 35 per cent of the time in such schools is given to related studies, like mathematics, drawing or science.

(*c*) The remainder of the time (15 to 25 per cent) is given to such subjects as English, civics, hygiene, and history.

The following table shows the relative amount of floor space usually given to each kind of subjects:

RELATIVE AMOUNT OF FLOOR SPACE

(Estimated for a separate Trade School, having an average enrollment of 300 pupils.)

FLOOR SPACE USED IN ROOMS FOR	AVERAGE NUMBER IN CLASS	AVERAGE PERCENTAGE OF TIME GIVEN TO SUBJECT	MINIMUM NUMBER OF ROOMS REQUIRED	AVERAGE FLOOR AREA PER ROOM	AVERAGE PER CENT OF TOTAL FLOOR AREA
Shopwork . .	10–15	50	10–12	1500–5000	65–85
Related subjects	10–20	33⅓	5– 6	500–1800	12–28
Non-vocational subjects . .	10–25	16⅔	3– 4	400– 700	3– 7

In addition to the above space, rooms for offices, lunch, shower baths, recreation, and storage must be provided.

It is clearly seen from this table that a large portion of the building must be devoted to shops. Since the primary purpose of a trade or industrial school is to fit the individual for useful and productive employment, the building must be planned to give the individual actual shop experiences, and the equipment and methods used must closely follow the best practice of the industry. It is safer to plan large shop spaces without interior partitions and then divide the space into shop, laboratory or classrooms as wanted, than to try to anticipate these needs in advance. For this reason the figures given in the above table can only be taken in a comparative sense.

Replies to Questionnaire. — The same nine schools replying to the inquiry regarding proper site for a school were asked to describe the type of building which should be selected in a design for a new trade school.

The replies were as follows:

"The building should be constructed along the lines of a *modern factory* of reinforced concrete, brick facing, with large windows, and ample ceiling height. The *governing idea* should be *flexibility*, the idea being to erect sectional partitions adjacent to shops and conduct each trade on a unit basis. Open plumbing, sufficient openings for light and power, gas and water, so that shops and classrooms can be enlarged or changed into other lines. Cast-iron inserts should be placed in the concrete ceilings on 4-foot centers so that shafting can be conveniently erected."

"Factory type with great flexibility. No permanent interior bearing walls. 'A loft subdivided to suit the tenant' is the important feature of the building. Design rooms for ample natural light in all shops and classrooms."

"Most approved methods of shop and factory construction for shops. Office construction should be used for classrooms. Maximum of utility, minimum of ornateness. Include both gymnasium and auditorium. Provide factory elevator to shops on upper floors and wide doorways."

"The kind of trades to be taught and number of pupils to be accommodated. Character of academic branches to be taught."

"A combination school and factory type. Rooms well lighted and ventilated. Dressing rooms and lockers on each floor. Simple finish and sanitary details."

"Attractiveness as distinguished from factory appearance. Make layout so that offices, classrooms, and shops are arranged for the best routing of material and projects."

"Factory type. Great flexibility in the interior. Unit construction. Materials and designs such as will make it possible to utilize the construction for 'project work.' Changeable interior to meet new conditions. Simplicity in construction. Factory facilities for routing material."

"Concrete construction which embodies fire protection, economy, and simplicity. Large rooms for shops."

"The best factory design."

An examination of these replies shows that the consensus of opinion regarding type of building is that the building should have "flexibility." That is to say, it should be designed so as to be capable of alteration to meet new conditions readily. In addition, the design should be such as to permit of a maximum of utility for the purpose in view. While the several schools, having in mind different conditions, differed in matters of detail, there was no essential divergency of opinion on these points.

Building and Equipment for a Trade or Industrial School. *The General Plan.* — The experienced school architect cannot alone solve the problem of combining the school and the factory. It will be necessary for him to obtain certain specific information by conferences with the school authorities. This information should include —

(*a*) The general character of the school.

(*b*) The number and kind of trades to be taught.

(*c*) The number of pupils the school shall be designed to accommodate.

(*d*) The relative time to be given to shop, related, and non-vocational work.

(*e*) A list of the equipment to be installed.

(*f*) The amount of money available for the plant and equipment.

(*g*) The facilities required for assembly rooms, gymnasiums, lunchrooms, and administrative quarters.

(*h*) A general scheme for the floor plan, showing the arrangement and location of rooms, based upon efficient teaching and administration.

In addition, there should be frequent conferences between the architect, the principal, and the shop teacher, so as to assure a plan based upon the combined experience of the builder, the school administrator, and the journeyman teacher.

As a final check upon the flexibility of the building for trade-school purposes and upon its design on the "trade unit" basis, the plans of the architect should be carefully checked by a comparison with other schools of a similar character, and with the best industrial plants. This comparison should be made jointly by the school authorities and the architect, and may be made from plans obtained from other schools or by personal visits and conferences with school officials in other cities.

Experience in the administration of trade and industrial schools is favorable to the " trade unit " plan. The design of the unit plan provides that all the school work shall be carried out and organized with a particular trade or industry in mind. Each trade should be allotted a given portion of the building, and all instruction connected with that trade should be carried on within the department. This includes the shopwork and related science, mathematics, and drawing. As a means of securing greater " flexibility," the room in which the related instruction is given should be near the shops. This arrangement will enable the instructors to connect the practical shopwork with the related instruction, and will make available much of the shop equipment for laboratory purposes.

Experience also demonstrates that from 10 to 15 pupils constitute an average class in shopwork, and from 10 to 20 in related subjects; also that the school should be constructed so that the pupils will be placed in situations which closely resemble the conditions of the trade or industry. To do this, the *factory type of school building* constructed on a " unit basis " has proven to be the most satisfactory.

A much larger floor space will be required, and more light and ventilation will be necessary than is common to school buildings. Factory windows and northern saw-toothed skylights should be constructed whenever possible. Interior partitions should be of light construction so as to be easily moved for the convenience of shops and classrooms. The floors should be designed with a large safety factor for installing additional equipment. Electric light and power service should be run in conduit with numerous switch boxes having extra capacity and extra light and power outlets.

Tool and stock rooms may serve two or more shops. Rooms for applied science, drawing, and mathematics will be more efficient if located near the shop. Ample provision should be made to deliver supplies and to remove from the shops the finished product.

Windows should extend nearly to the ceiling, and should be set with as little space taken up by mullions as possible. The area of the glass surface should in general equal one-fourth of the floor space.

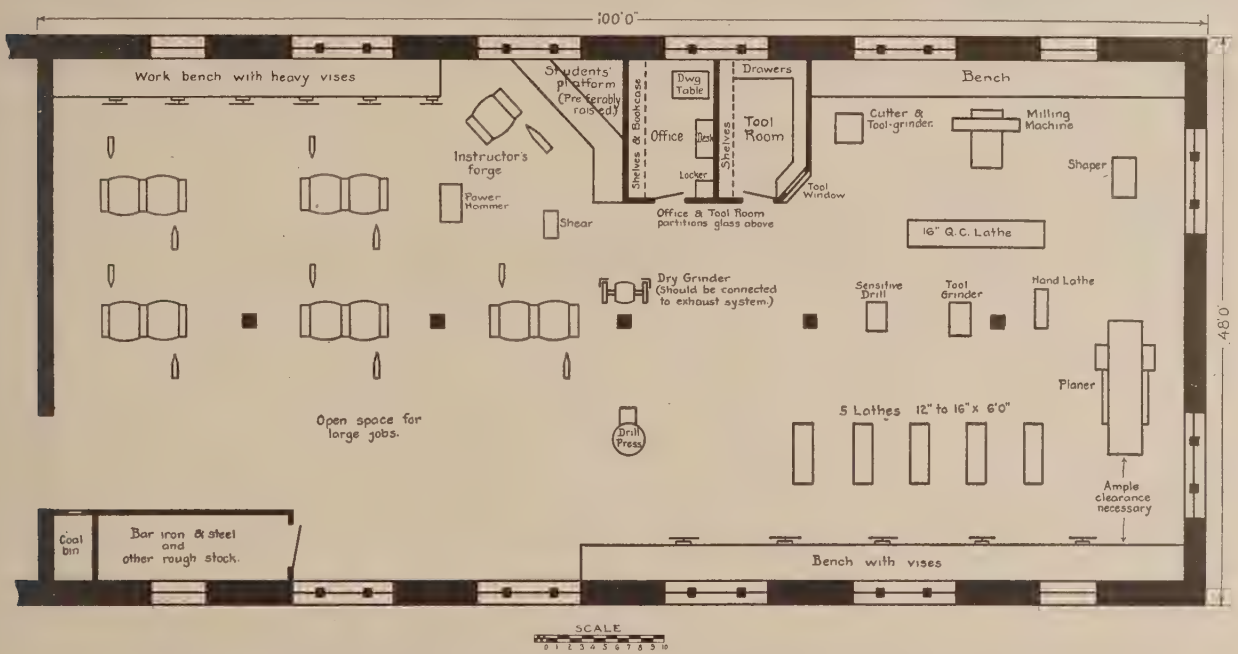


FIG. 131. — TYPICAL SHOP EQUIPPED FOR A UNIT TRADE COURSE IN FORGE AND MACHINE SHOP.

Since the interior of a vocational school resembles the factory, the construction will be less expensive per cubic foot than the general school.

A Typical Shop. — A concrete example of the foregoing statements may be had from the following description of a typical shop:

(*a*) Size: The floor space should be from 1,500 to 5,000 square feet.

(*b*) Light: On two sides, and supplemented by skylights whenever possible. The window-glass area should not be less than one-fourth the area of the floor space.

(*c*) Floors: Should be wood or wood paving blocks in all shops where edged tools are a part of the equipment.

(*d*) Walls: Brick unplastered for exterior walls. Tile or light frame for interior partitions.

(*e*) Ceilings: Vary from 12 to 32 feet. High ceilings for carpentry, electrical work, and plumbing.

(*f*) Heating and ventilation: About 5 to 10 degrees less than for usual classrooms. Ventilation not less than 40 cubic feet of air per pupil per minute.

(*g*) Stock, tool, and supply rooms: Adequate to contain full length supplies. These rooms may be combined for two or more shops. Drying rooms for lumber and glue work are necessary for woodworking shops.

(*h*) Related subjects room: Located close to shop for greater correlation of subject matter and convenience of teacher.

(*i*) Electric light and power: Extra light in shops, with extra light and power outlets for equipment.

(*j*) Plumbing: Toilet and washroom facilities should be accessible to all shops. One water-closet to each 15 pupils; one urinal for each 15 boys. Four lavatories, and one drinking-fountain for each shop.

(*k*) Cases for storage: Provide adequate cases for storing tools and supplies.

(*l*) Blackboard: Each shop should have not less than 80 square feet of blackboard.

(*m*) Benches and fittings: Full size and fitted with vises, etc., as in a commercial shop.

General Specifications

Room	Floor Area (Square Feet)	Ceiling Height in Feet	Minimum Ratio Glass Surface to Floor Area	Kind of Floor	1 Electric Light Outlet per 100 Square Feet (Floor Area Wattage)	Average Temperature in Zero Weather
						Degrees
Machine shop .	1,800–5,000	12–14	1:4	Wood	125	60–65
Carpentry . .	1,800–5,000	18–32	1:4	Wood	100	60–65
Masonry . . .	1,800–4,000	13	1:4	Cement	100	60–65
Sheet metal . .	1,800–4,000	13	1:4	Wood or cement	100	60–65
Plumbing . .	1,500–4,000	18–32	1:4	Cement	100	60–65
Shop electricity	1,500–4,000	18–32	1:4	Wood	100	65–70
Automechanics .	1,500–4,000	13	1:4	Cement	125	60–65
House painting .	1,500–4,000	13	1:4	Wood or cement	125	65–70
Related science	500–1,800	13	1:4	Wood	125	70
Mathematics .	400– 700	13	1:5	Wood	80	70
Related drawing	500– 900	13	1:4	Wood	125	70
Non-vocational subjects . .	400– 700	13	1:5	Wood	80	70

This is not intended to include all the shops which may be provided.

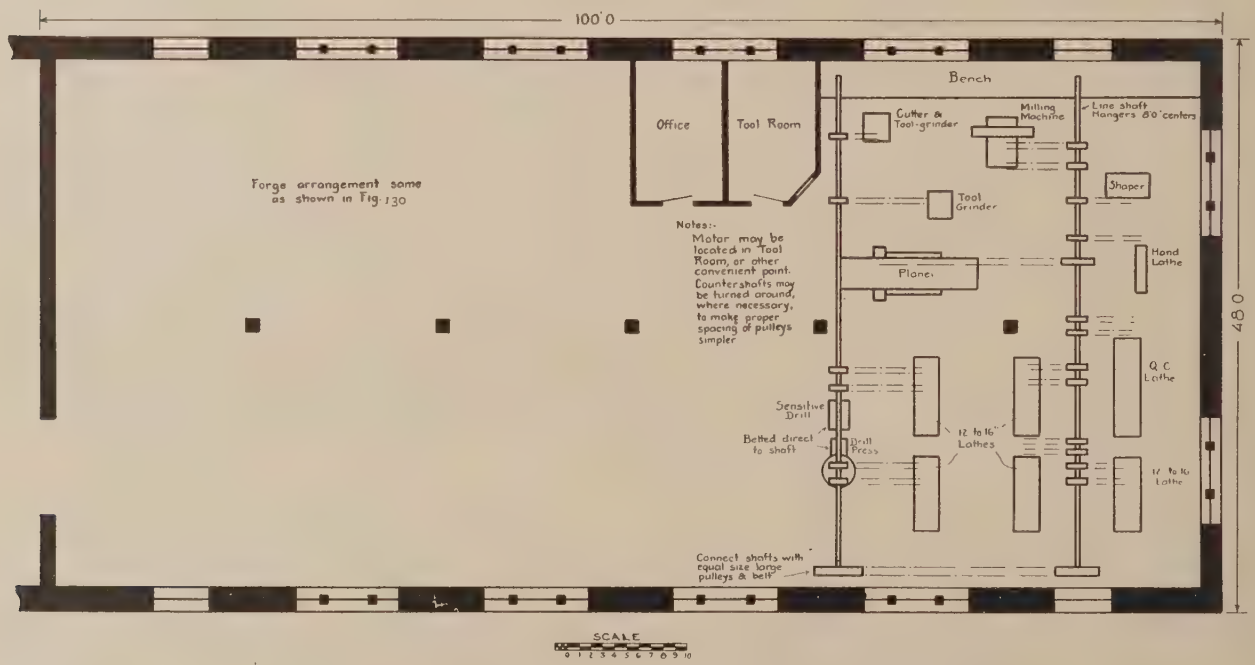


Fig. 131 A. — Typical Shop Equipped for Unit Trade Course in Forging and Machine Shop.

(*n*) General tools and machinery: Should be commercial tools of average capacity and represent the industry of the community.

(*o*) Individual tools: Usually one set for each pupil in the class. Edge tools should be individual. Special hand tools in lots of one or more and kept in tool room.

(*p*) Red Cross cabinet: Containing sterile dressings for cuts and wounds, and other simple first-aid apparatus.

[1] *Machine Shop.* — A typical machine shop should be equipped with up-to-date machines, such as will enable the school to turn out productive work in commercial quantities. The installation of equipment should be arranged for routing the work from one machine to another with the greatest efficiency. Tool and stock rooms, locker and wash rooms, should

[1] A number of typical shop floor plans have been prepared and submitted to teachers and Federal agents, each of whom is a specialist in one or more shop subjects. A room containing approximately 4400 square feet was selected as a typical floor space. The installation of equipment has been indicated in each plan, and partitions in most instances have been placed which divide the main shop into auxiliary shops or classrooms. These partitions should be of light construction, of a temporary nature, so that their location may be adjusted without great expense. In all cases the equipment was placed so as to provide for the routing of material and to conserve open floor spaces for use in productive work.

be provided to accommodate the needs of the shop.

The machine shop should be located on the ground floor, and near other shops which do work related to machine-shop practice. When the plan of the building will permit, saw-tooth skylights should be used, as well as factory windows.

The following is a brief list of the general tools which the equipment should include for a class of 10 to 15 pupils:

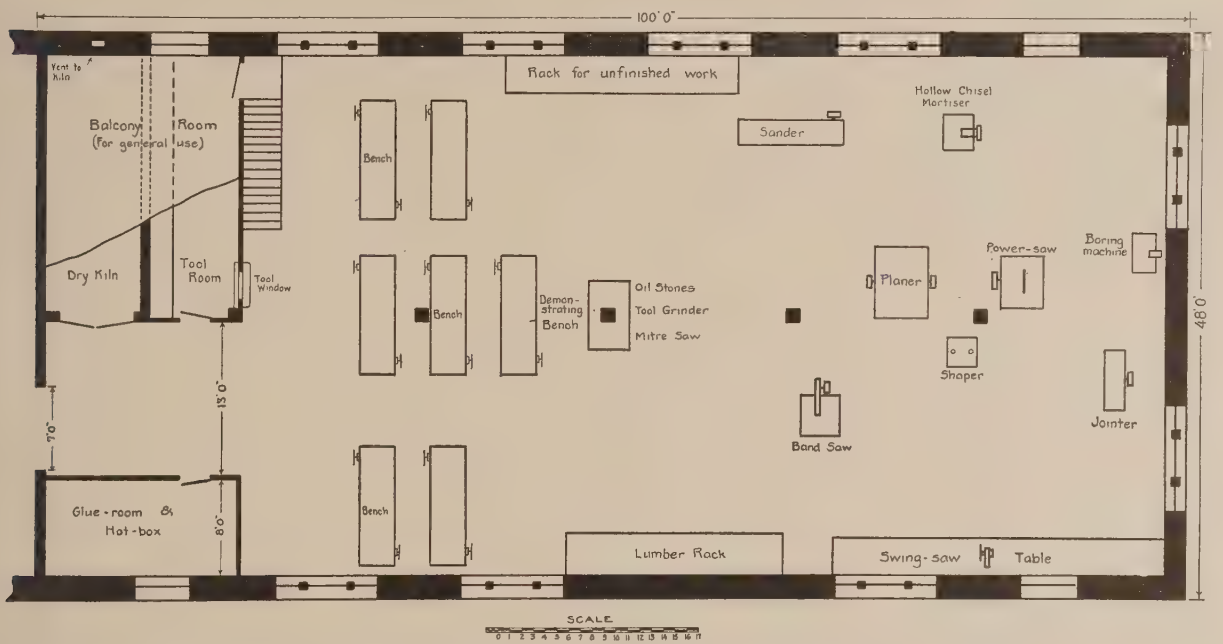


FIG. 132. — TYPICAL SHOP EQUIPPED FOR UNIT TRADE COURSE IN CARPENTRY AND CABINETMAKING.

6 8-foot benches with 3½-inch machinist vises, tops built up of 3-inch stock on edge.
6 metal-working lathes of different capacities and makes, including at least one turret and one taper turning attachment. One quick-change gear lathe should be included. High-speed and carbon-steel tools should be provided. Many of these can be made in the shop.
1 planer with a capacity of not less than 8 feet.
1 shaper not less than 16 inches.
1 universal milling machine.
1 back-geared drill press — capacity not less than 24 inches.
1 two-wheel grinder.
1 forge and anvil,
1 annealing furnace,
} Unless otherwise provided.
1 bench punch and shear.
Sets of taps and dies, and hand tools, adequate to accommodate a class of 10 to 15 pupils.
Adequate supplies of steel, iron, and brass castings, for use in work on productive projects.
Value of equipment, $5,000 to $15,000.
Annual cost of supplies per pupil, $10 to $15.

Carpentry and Cabinetmaking. — The following is a description of a typical shop for carpentry and its allied trades. Whenever the woodworking industries of the community are large enough, unit trades in carpentry, cabinetmaking, mill work, etc., should be established.

Woodworking shops need a large amount of floor space. They should contain woodworking machinery, carpenters' benches, and from 1000 to 2000 square feet of floor space available for the assembly and construction of productive projects. The installation of the woodworking machinery should be planned when the room is designed, so that provision may be made for shafting and for arranging the machines for routing material economically from one machine to another. All machines should be connected to an exhaust system to remove the shavings and sawdust. The exhaust system may be motor-driven, and arrangements made for an automatic control which starts the exhaust motor whenever any woodworking machine is being operated.

Tool rooms, lumber rooms, locker, and wash rooms should be provided in the plans.

As most lumber is received without being thoroughly kiln dried, it is desirable to have a drying room fitted with steam coils properly ventilated, in which to store lumber to be used in project work.

Woodworking shops also need a gluing room, in which facilities are provided for heating stock and warming glue.

The selection of equipment should include only tools that are recognized by the trade as standard.

For 10 to 15 pupils, the equipment should include:

1 12-inch saw table,
1 jointer,
1 hollow chisel mortiser,
1 24-inch planer,
} Or one Universal woodworker if floor space is small.

1 power sander.
1 glue pot.
10 to 15 sets of hand tools.

Supplies of dimension and finish lumber for productive shopwork.

Value of equipment, $1,000 to $3,000.

Annual cost of supplies per pupil, $10 to $15.

Electrical. — The work of a general electrical shop includes shopwork in house wiring, armature and field winding, power-plant operation, telegraph and telephone, and general repair work. In some schools it will be possible to have separate rooms equipped for each of these occupations. Each shop should be equipped with the usual tool and locker rooms, and in addition they should be supplied with adequate electrical power facilities for experimental and practice work.

Rooms in which instruction in house wiring is given will need a large amount of floor space on which to erect panel partitions, and even full-sized buildings for practice wiring.

In the construction of the building a large number of outlets should be left in the walls and floors for future electrical connections. These should be connected to a switchboard by means of oversize conduit, so as to enable future changes in the capacity or number of conductors.

Equipment for electric wiring for 10 to 15 pupils:

1 skeleton house constructed of full-sized material.
10 to 15 sets of hand tools (hammers, pliers, screwdrivers, etc.).
2 sets of brace and bits with angle and bit extensions.
1 standard high-reading ammeter.
1 standard low-reading ammeter.
1 standard high-reading voltmeter.
1 standard low-reading voltmeter.
2 motor-generator sets.
2 testing magnetos.
2 sets of stocks and dies.
2 soldering irons and torches.
2 sets of pipe cutters.
3 annunciators.
1 12-inch or 14-inch engine lathe with screw-cutting attachment.

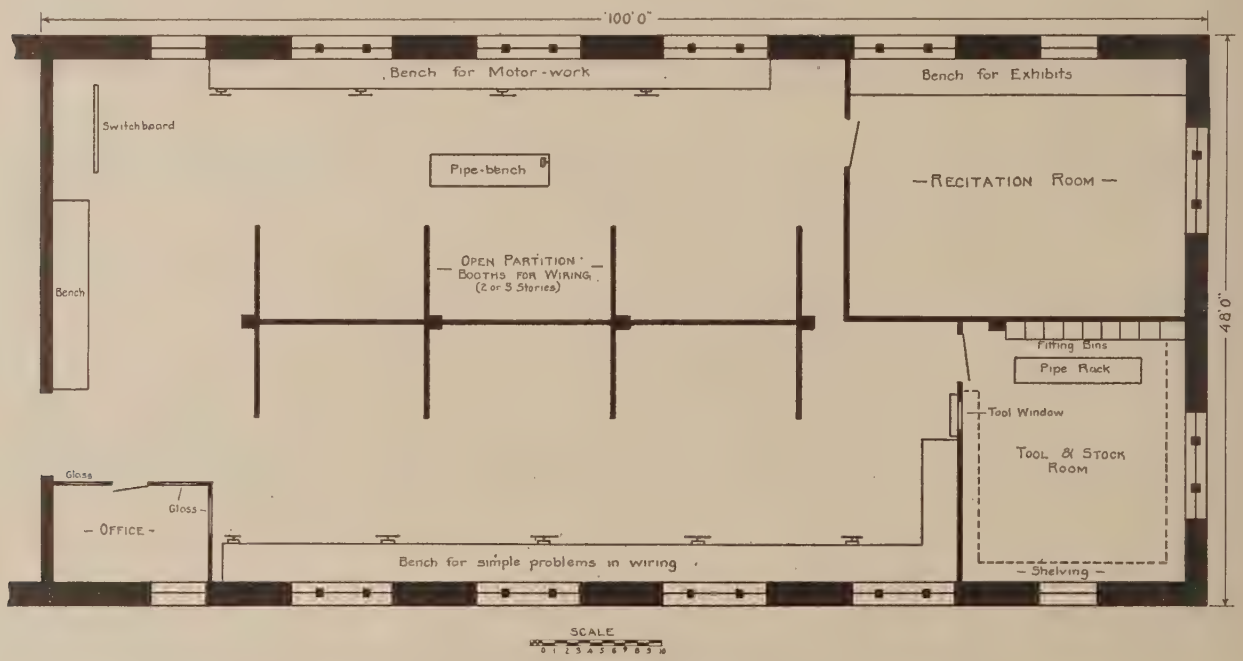


Fig. 133. — Typical Shop Equipped for Unit Trade Course in Electrical Trades.

A stock of motor and generator parts, armatures, transformers, and magnets for wiring practice.

1 gas furnace and soldering irons.

Benches with machinists' vises for pupils' use in practice work.

Supplies of bell wire, new code rubber-covered wire, bells, push buttons, conduit, metal molding, flexible conduit, duplex wire, and lamp cord, etc.

Fittings for pipe and metal molding, outlet boxes, pull boxes, switchboard fittings, solder, and flux, etc.

Value of equipment, $1,000 to $3,000.

Annual cost of supplies per pupil, $10 to $15.

Printing. — Rooms to be utilized for instruction in printing should be lighted on two sides and with northern light if possible. The light should be diffused over the entire room, and the glass area larger than that furnished to the usual room. In wiring the building for electric

lights ceiling outlets should be left for drop cords to type cases.

As machines in the printing shop are motor driven, it is desirable to locate the presses so that wiring may be run to machines through concealed conduit. The advice of a skilled pressman should be obtained in locating the machines. If the equipment is to include linotype and monotype machines, provision should be made for the installation of these machines in rooms apart from the room to be used for the general course in printing.

wood finishing to have a room for varnishing that may be made dust proof, and which is supplied with good light, heat, and ventilation.

In the general shop cross sections of house partitions containing walls, ceiling, door and window openings should be constructed, on which to give demonstrations and practice work. As productive projects brought into this shop to be finished will necessarily occupy a considerable amount of floor space, a large floor area will be required, as well as additional room in which to store the finished articles.

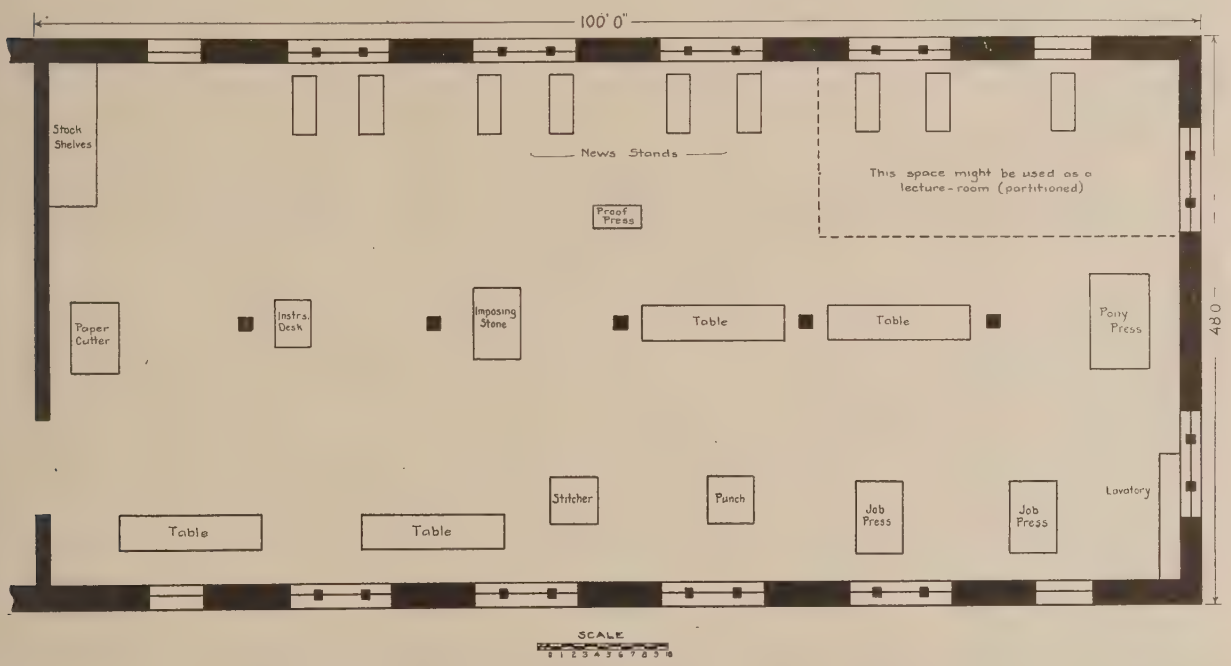


FIG. 134. — TYPICAL SHOP EQUIPPED FOR UNIT TRADE COURSE IN PRINTING.

Printing equipment for 8 to 12 pupils:

6 double cabinets or racks containing cases for job and news type, leads, slugs, rules, and spacing.

1 imposing stone, 32 by 60 inches.

1 paper cutter, 30 inches.

2 job presses, not less than 10 by 15 inches.

1 cylinder press, pony size.

1 proof press.

1 punch machine.

1 stitcher.

Adequate supplies, such as type, leads, slugs, rules, spaces, sticks, galleys, chases, leaders, quads, quoins, furniture, and stock of paper for productive job work.

Value of equipment (not including cylinder press), $1,000 to $10,000.

Annual cost of supplies per pupil, $5 to $10.

House Painting and Decorating. — A room fitted up for instruction in house painting and wood finishing should be well ventilated, well lighted, and furnished with a stock room that is fireproof. It is necessary in

For a class of 10 to 15 pupils, the school should provide:

10 to 15 sets of good brushes; to include one each of: 2-inch varnish, 3-inch varnish, 3-inch shellac, 2-inch stain, 3-inch stain, 2-inch paint, 3-inch paint, 4-inch paint, 4-inch flat duster, and 3 assorted sizes of sign-writers' pencils.

10 to 15 easels for color and drawing work.

3 each of 6-foot and 8-foot step-ladders.

2 each 16-foot and 18-foot extension ladders.

2 pairs ladder jacks.

6 pairs tilly trusses 9 feet.

1 lot of plank for scaffolding.

15 putty knives.

Cases with metal drawers should be provided as follows: 12 to hold 5 pounds each of dry or pigment color; 3 to hold 20 pounds each of same.

3 60-gallon metal tanks for oil, benzine, and turpentine.

2 drop cloths 24 by 36 feet.

3 drop cloths 4 feet 6 inches by 32 feet.

Adequate supplies of drawing paper, cardboard, paintbrushes,

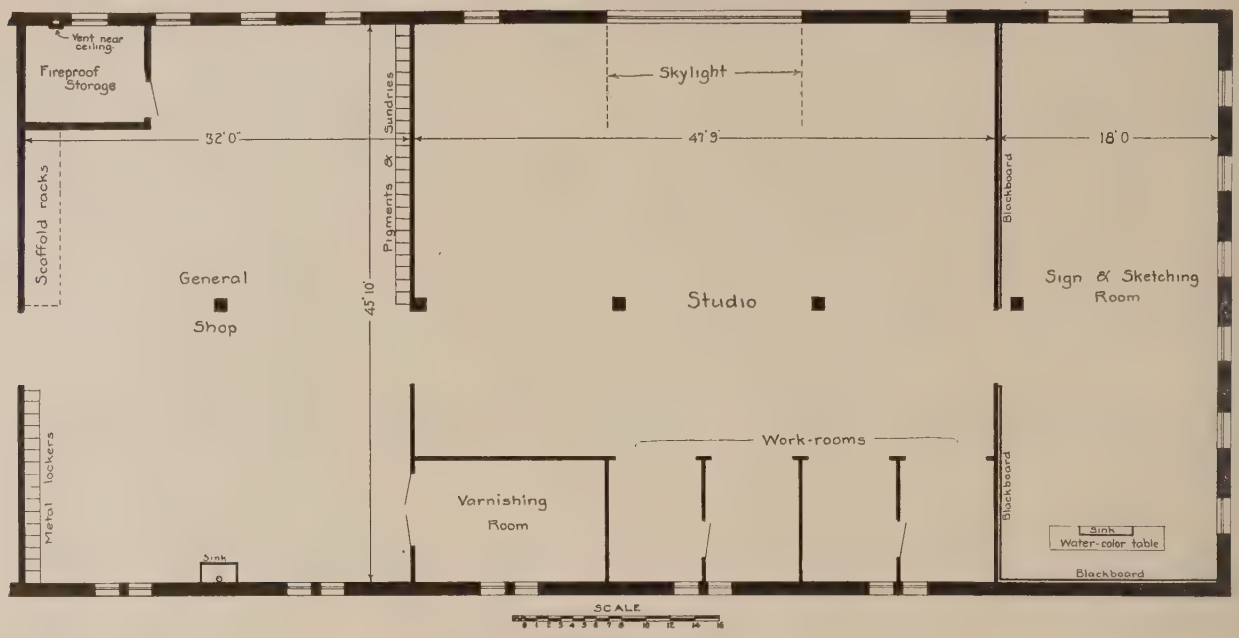


FIG. 135. — PAINTING AND DECORATING WORKSHOP.

charcoal, rest sticks, colors dry and in oil, oils, stains, varnish, and lead for practical work.

Value of equipment, $400 to $1500.

Annual cost of supplies per pupil, $5 to $10.

Sheet Metal. — A room fitted up for a sheet-metal shop needs ample floor space. Projects made of sheet metal often require a large area in which to assemble the parts. As pattern drafting is an essential part of the work in the sheet-metal shop, large tables on which to develop and lay out patterns should be provided as a part of the equipment. Good light will also be necessary for this work.

For a class of 10 to 15 pupils, the equipment should include:

5 double drafting tables, tops 42 by 54 inches.
3 work tables, tops 48 by 96 inches.
1 beading machine.
1 burring machine.
1 bench plate.
1 brake, 3 feet.

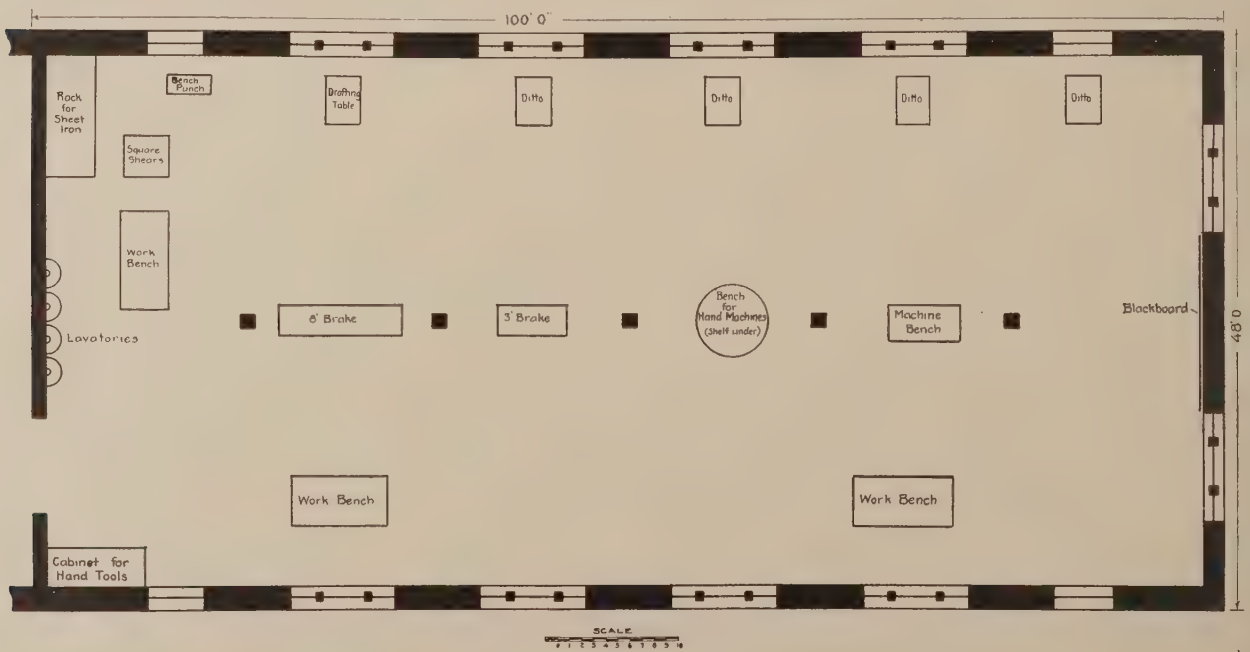


FIG. 136. — TYPICAL SHOP EQUIPMENT FOR A UNIT TRADE COURSE IN SHEET METAL.

1 brake, 8 feet.
1 crimping machine.
1 beak horn.
1 blow horn.
1 folder machine.
2 gas furnaces.
1 forming machine.
1 each hollow, round, straight mandrel.
1 square shears, 36 inches.
1 circle shears, 32 inches.
1 double seamer.
1 turning machine.
1 wiring machine.
1 bench punch and shear.
10 to 15 sets hand tools, and miscellaneous small tools.
Value of equipment, $750 to $2000.
Annual cost of supplies per pupil, $5 to $15.

1 skeleton of a building for practice work.
5 plumbers' kits.
6 each of 10-inch and 14-inch pipe wrenches.
3 each 18-inch and 24-inch chain tongs.
2 each 24-inch and 36-inch chain tongs.
Sets of stocks and dies, cutters, and supplies for lead work.
A supply of water, gas, and lead pipe, fittings and plumbing fixtures for practice work, including water-closets, urinals, lavatories, sinks, bath tubs, trap vents, and drain and drainage pipes.
Value of equipment, $1000 to $2500.
Annual cost of supplies per pupil, $10 to $15.

Pattern Making. — In general construction, a pattern-making shop is similar to a carpenter shop. Unless the school includes a foundry, a small furnace for melting white metal or brass should be available. This should

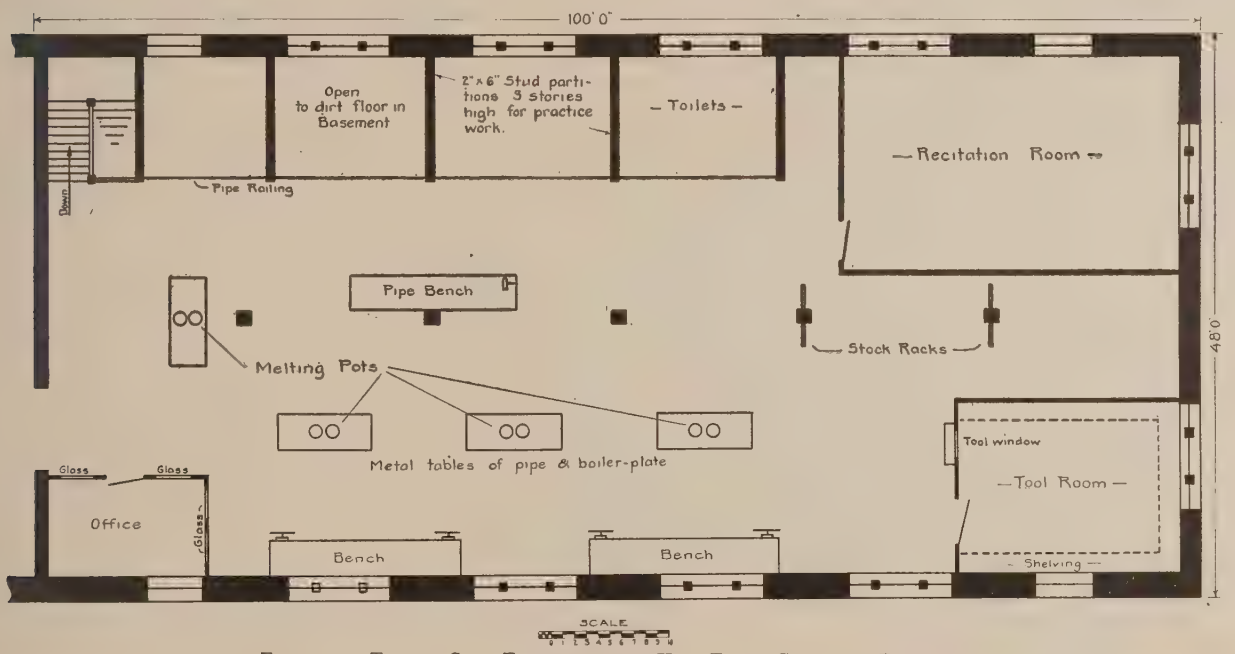


FIG. 137. — TYPICAL SHOP EQUIPPED FOR A UNIT TRADE COURSE IN PLUMBING.

Plumbing. — In designing a room for plumbing, provision should be made for more than the average ceiling height. This is necessary in order to provide for the installation of plumbing systems in practice houses of at least two stories and basement. In some cases, schools have arranged for two floors of the building to be given to plumbing, and cut large openings in the floors through which to extend the rough work. In any case, it is necessary to provide 500 to 700 square feet of earth floor space for installing drainage systems in tile and cast iron pipe.

For a class of 10 to 15 pupils, the equipment should include:

3 metal-topped tables, tops ¼ by 42 by 96 inches.
12 melting pots with gas burners (or plumbers' furnaces).
2 plumbers' gasoline torches.

be in a separate room with molding benches, sand, etc., for making test runs of certain patterns. A pattern shop usually requires large storage space for finished patterns. These should be in a separate room.

A typical equipment includes:

Benches for 10 to 15 pupils.
1 band saw of not less than 30 inches.
1 8-inch jointer or bench planer.
1 saw table.
1 pattern-maker's lathe.
1 trimmer.
3 wood-turning lathes.
1 glue pot, 2 quarts capacity.
1 set of flasks for molding.
2 sets molder's small tools.
2 barrels of molding sand.
1 lot of white metal.
1 furnace for melting white metal.

10 to 15 sets of hand tools.
A stock of white pine for patterns.
Value of equipment, $800 to $2000.
Annual cost of supplies per pupil, $5 to $10.

Related Subjects. — As the vocational industrial shop differs from the usual manual training room, so the related science laboratory differs from the usual physics or chemistry laboratory. More floor space must be provided for demonstration in applied science. The course of study should require the use of full size apparatus, such as block and tackle, jack screws, derricks, gasoline engines, and commercial testing machines, as well as tables and apparatus for making analyses of paints, oils, fuels, electrical tests, etc., which may be related to the various industrial subjects.

FIG. 138. — WORCESTER BOYS' TRADE SCHOOL, WORCESTER, MASS.

The Science Laboratory should be equipped with a projecting lantern, and should be located on the ground floor or provided with a freight elevator in order that testing equipment may be moved in and out of the room. In wiring the room for light and power service, a switchboard should be installed with a large capacity for experimental work with both high and low voltage.

Storage rooms and storage cases for the science equipment should be provided in the plans for the building. These can be constructed with temporary partitions and adjusted from time to time to meet the needs of the room.

The Related Drawing Room need not differ greatly from the usual drawing room as planned for high schools. Dark rooms for printing and developing blue prints and the installation of blue-printing machines, should be available. It is desirable to have separate rooms for mechanical and architectural drawing, as the models and instruction material will differ in the two types of instruction.

In addition to the usual drawing tables, storage facilities for blue prints should be liberally provided. In the factory type of construction, it will be possible to adjust the relative amount of floor space between shops, lecture rooms, and rooms for related subjects, as the school develops.

The Lecture or Classroom in vocational schools may be the usual classrooms fitted with either chairs or school desks, and located away from the noise of the shops.

The General School. — Whenever plans are being made for giving vocational training as a department or class in a general school, the architect should incorporate in his plan the same provisions for shops as have been outlined for a factory building.

Old Buildings, Factories, or Industrial Plants as Temporary Quarters. — Old buildings or industrial plants which may be used for vocational schools should at the best be regarded as temporary quarters, in which to develop vocational education in the community. Few buildings have been constructed in the past which may be adapted to the needs of the productive shop.

It is often desirable for the community to begin vocational schools in these buildings, in order that a new building may be more efficiently planned. As a rule, school authorities should not regard old buildings which have been abandoned or disused as fit quarters in which to establish vocational schools. Where such schools are established, it will often be necessary to enlarge rooms by combining two or three and removing the partitions. Quarters obtained in industrial plants should also be regarded as temporary, unless the plant furnishes opportunities for obtaining practical experience in the industrial subject for which the school is organized.

The Part-time School. — The conditions under which part-time pupils are instructed do not usually require special buildings, although, where this work is extensive, as in Milwaukee, a special building will in time result. The all-day trade school usually has all the facilities for this instruction. It is impossible at this time to define in detail all of the varieties of part-time classes which may be organized under the provisions of the Federal act.

The Evening Industrial School. — Evening instruction can be given only in such subjects as will increase skill or knowledge in the occupation in which the worker is

engaged as his daily employment, or as will lead to promotion or advancement in that work. The time available in an evening school is so short that it is impossible to teach a skilled trade to any one unless he is engaged in daily work affording him opportunity to apply the skill or knowledge gained in the evening school, or unless the daily employment gives an experience which will enable the worker, with the knowledge or skill acquired in an evening school, to secure promotion in that occupation. The work can be most effectively given when workers in similar or allied occupations are grouped together.

The all-day school is suitable for evening instruction if sufficient light is provided. Since much of the instruction in the shops is trade extension, the equipment must include commercial tools and machines.

A Few Type Buildings. — At different points throughout this chapter will be found illustrations showing the floor plans and elevations of a few of the buildings used in the United States for industrial and trade education. It was deemed advisable to present illustrations of the three different types of building discussed in the foregoing pages, the new building built for the purpose, the shop or factory adapted for the purpose, and the old school building remodeled. As there are pronounced variations in each type, a number of illustrations are given.

No attempt has been made to include all or any considerable number of the many excellent buildings which are to an increasing degree being used for industrial and trade education. A few have been selected for presentation solely from the point of view of their usefulness to illustrate the different types and variations of types of buildings used in the country.

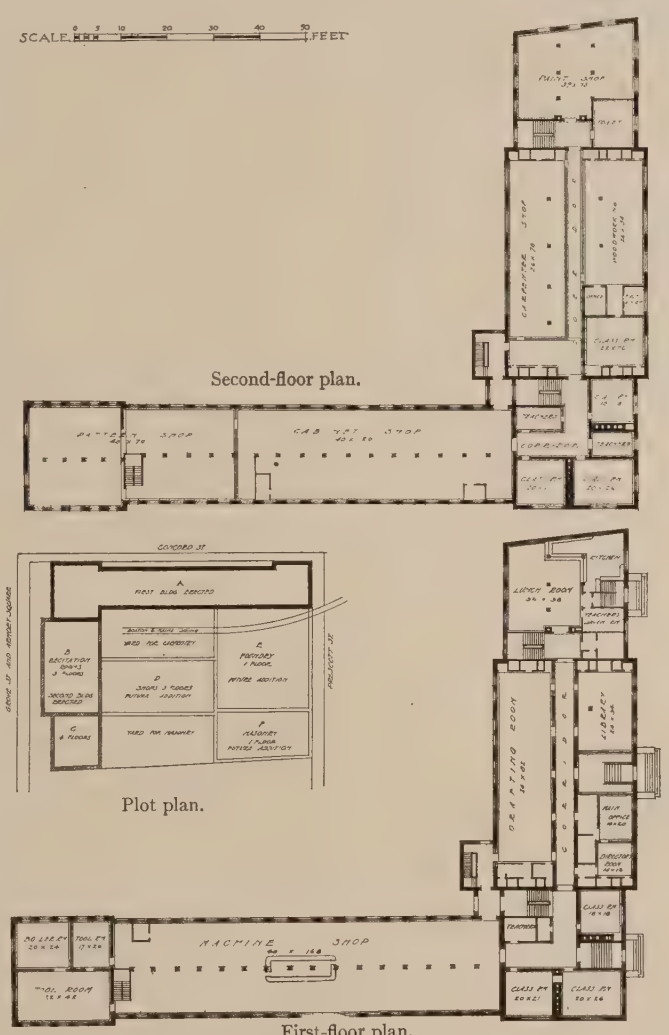


FIG. 139. — WORCESTER, MASS., BOYS' TRADE SCHOOL.

In order that these illustrations may be of larger interest and helpfulness to those studying the problems of industrial school construction and equipment, this section of the chapter gives a brief resumé of the main facts about each school presented.

The Worcester Boys' Trade School, Worcester, Mass. History and Location. — The Worcester Boys' Trade School was established in February, 1910, with an enrollment of 52 boys. It is located one block from the Worcester City Hall on a tract containing 45,000 square feet. Adequate car service makes the institution accessible from all parts of the city and vicinity. Natural light and ventilation are not obscured or interfered with by adjacent buildings. The school is supported by public funds.

Buildings. — Buildings especially designed for the purpose were erected to house the school. The left wing of the main structure, a recitation building of three floors and a basement, and a shop of three floors, was built in 1910. In 1913 the main building was constructed. The buildings are of brick, permanent brick and tile partitions, hardwood floors, and electric lighted. The main building contains the gymnasium, electrical and steam practice departments, two recitation rooms, administrative offices, library, drafting room, carpentry department, and paint shop. On the third floor is the printing department and assembly hall. Plans for future enlargement of the institution contemplate the erection of buildings as large again, equipped with all necessary machinery. The present value of the structures now in use, including heat and lighting plant, is given at $146,657.62. Natural light and ventilation of buildings are ample.

Classrooms for related subjects join the shops. Other

classrooms are apart from the shops, but all are in the same building. The estimate of floor space varies per pupil for the different departments, being: Machine shop, 100 feet; electrical, 110 feet; steam power plant, 175 feet; drafting room, 50 feet; printing, 152 feet;

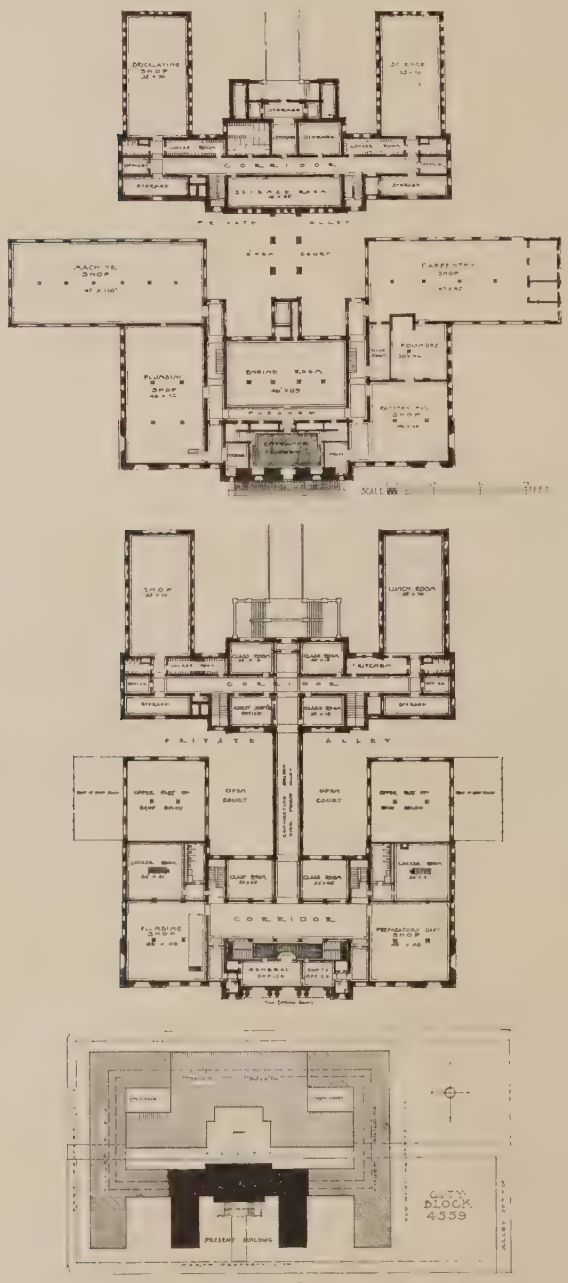


FIG. 140. — DAVID RANKEN, JR., SCHOOL OF MECHANICAL TRADES.

pattern making, 149 feet; cabinetmaking, 96 feet; carpentry, 130 feet; painting, 214 feet.

Equipment and Courses. — Equipment is valued at $61,099.28, apportioned as follows: Machine shop, $32,270.31; carpenter shop, $2440.53; cabinet shop, $3830.51; pattern shop, $7414.01; paint shop, $237.74; electrical department, $6284.27; drafting department, $2071.77; printing department, $6550.14.

The shop student capacity is: Machinist, 65; electrical, 20; steam power plant, 20; drafting, 44; printing, 15; pattern making, 24; cabinetmaking, 50; painting, 10; carpentry, 16. The school is able to take care of twice as many boys as the capacity of the shops indicates, because the classes are so arranged that it takes two weeks to complete the cycle of instruction. One-half the pupils are in the shop and one-half in school each week.

Miscellaneous Data. — There is a minimum age for entrance of 14 years. All courses require four years for completion, and there are 42 weeks in the school year. No part-time instruction is given. There is an evening school which requires 52 sessions for all except the gas-engine course, there being 35 sessions required for that. No extension work is conducted.

The David Ranken, Jr., School of Mechanical Trades, St. Louis, Mo. History and Location. — This institution was endowed in 1907 with an initial gift of $1,500,000 by the philanthropist whose name it bears. A subsequent donation brought the total up to $3,000,000.

The terms and conditions of the endowment as prescribed by the donor are that it "is to be used for training and fitting boys and men for the mechanical and manual trades and occupations . . . who shall be skilled in their respective trades and occupations and have such education as will best fit them to serve the community and the state in such occupations." The founder believed there was need of an institution to provide education in ordinary mechanical trades and to appreciate the dignity of labor. His idea was that public schools and other educational institutions had "not only failed to provide training in mechanical trades, but had tended to draw boys away from the consideration of them by the creation of a prejudice against manual labor. Boys who could have succeeded as mechanics were, in consequence, caused to engage in pursuits either already overcrowded or for which they had no aptitude." Mr. Ranken stipulated that the trades taught in the school created and maintained by his money should be those in which there is a demand for practical workmen in the community and the state.

The site was donated by the founder. It is 300 by 600 feet, or approximately 3 acres, located in a residential part of the city of St. Louis which is rapidly becoming industrial in character. It is not, and, by reason of streets on all sides, cannot be overshadowed or crowded by adjacent buildings. There is thus an assured maximum of natural light and ventilation.

It is accessible by a good car service reaching all parts of the community. The plant at present covers about

30 per cent of the ground. The remainder is available, and ample for recreation purposes and future additions to the buildings.

Buildings. — In 1909 the first of the buildings was completed. It is a three-story brick, especially designed for the purpose. Careful attention was paid in the plans to lighting, heating, and ventilation. Electric lighting is used throughout. It has brick partitions, and the flooring is carbolithic laid on cement, except in the shops, where wood block is used. The building was erected during a period when material was cheap and wages lower than in recent years, and its total cost was $170,000, and initial equipment valued at $9000.

This building faces Cook Avenue, and contains six shops, a drafting room, science room, library, classroom, and administrative offices.

The second building was completed in 1912, and was also especially designed for its purposes. It is of brick, with hollow tile partitions, carbolithic floors laid on cement, except in shops, these being of wood block. This structure is modern in all respects and well suited for its functions. The completion of this building brought the total value of buildings of the David Ranken, Jr., School up to approximately $500,000, as estimated in 1918.

Equipment and Courses. — The equipment for teaching trades was inventoried in April, 1918, as: Bricklaying, $1200; painting, $1000; electrical, $9000; preparatory, $1600; machine shop, $30,000; plumbing, $3000; pattern shop, $4000; carpentry shop, $7500; science, $3500; total, $60,800. The steam engineering class uses boiler and engine room equipment not included in the above figures.

There are three schools — day, evening, and day coöperative. The institution "aims to give the boy without experience training similar to that received by the apprentice; to the apprentice such instruction as will round out his shopwork; and to give to the journeyman information concerning his trade that is not given in his shop. It also aims to obtain the coöperation of manufacturers who acknowledge the limitations of shop instruction, and who will send their apprentices to the school to study the theory of their trade." The institution is therefore intensely practical. The trades instruction is almost entirely individual, and pupils, except in stationary engineering, may enter at any time. The great majority of the pupils in the evening school are actively engaged in the trade, the theory or practice of which is taught in the school.

Requirements for Admission. — For admission, boys must be white, 15 years and over, who have completed the sixth grade of the public schools or its equivalent. In the day school, exception is made in favor of boys 14 years of age who have completed the work of the sixth grade or equivalent, are physically qualified for the work, and exhibit particular aptitudes for trade instruction. All applicants must be in good physical condition. Any candidate with trade experience, but who lacks the educational qualifications, may make up the latter in special classes formed by the school for preparatory instruction.

Coöperation of Employers. — The coöperative classes were organized at the suggestion of the St. Louis branch of the National Metal Trades Association for the instruction of apprentices in the machinists' and pattern-making trades. The association, through its shop superintendents, provides complete instruction in the use of tools and machines, leaving the theoretical instruction to the school. The institution holds out a standing invitation to employers of apprentices to avail themselves of the work offered in the coöperative classes. A minimum of 16 years of age is required for admission. Employers pay $15 per year tuition for each apprentice, and at the same time pay the regular wages for time spent in attendance at the school.

Associations of manufacturers, contractors, workmen, and men and boys who are employed by the day but attend evening classes, have all shown considerable appreciation of the school. Employers whose apprentices are in the coöperative classes have expressed themselves as pleased with results, and the general attitude of the public toward the institution is that of cordial good will and respect for its work.

Miscellaneous Data. — A nominal tuition is charged in order to cause pupils to take the work seriously and appreciate the opportunity, as well as for the purpose of eliminating the undesirables with no definite purpose, who drift in and out of absolutely free schools without completing any course. Pupils are required to provide their own drawing instruments, paper, and incidental material. Tools and supplies in the shops are furnished by the school.

There were in March, 1918, a total of 302 graduates of the day-school regular trade courses, and 90 graduates of the part-time courses. The total enrollment for the day school was 1402; part-time students, 312; evening students, 4000.

The school year for day pupils covers a period of 46 weeks, divided into three terms. The evening-school year covers two terms of three weeks each, beginning in October and in January.

The Williamson Free School of Mechanical Trades, Williamson School, Pa. History and Location. — December 1, 1885, Isaiah U. Williamson founded the school which bears his name. On October 21, 1891, the institution, with an endowment of about $2,000,000,

FIG. 141. — FREE SCHOOL OF MECHANICAL TRADES, WILLIAMSON, PENNSYLVANIA.

became a reality and opened its doors for its first session. The endowment is its sole support. No fees of any sort are charged.

The declared purpose of the founder was to give to poor and deserving boys a good English education; to train them in habits of morality, economy, and industry; and to teach them trades. The school is distinctly vocational, and only for pupils who intend to follow for a livelihood the trades taught them there. No others will be admitted.

The institution is located at Williamson School Station on the central division of the Pennsylvania Railroad, about 16 miles from the Broad Street Station in Philadelphia. The Media Short Line electric cars from the Sixty-ninth Street Terminal, Philadelphia, also reach the property. The school owns a tract of 230 acres of land, that part not in use for campus and buildings being devoted to agriculture and the teaching of agriculture. The site is a beautiful one and well suited to its purpose.

Buildings. — A few of the buildings were acquired with the land. The rest have been constructed especially for the purposes for which they are being used, and most of them were erected by student labor, giving practical instruction to the students of the various trades involved. The buildings are of brick, concrete, and wood; floorings are of wood and concrete, and in the shops the partitions are of yellow pine placed as needs arise. Owing to the amount of land possessed by the school, the campus has been so arranged that each building has a maximum of light, air, and distance from other buildings. In the main the buildings have been carefully designed for their purpose, and have met the requirements satisfactorily. Some of the buildings erected by the students are somewhat pretentious, of pleasing architecture, and well built. Electricity is used for lighting, and there is a central power and steam-heating plant.

Equipment and Courses. — In the shops approximately 163 square feet of floor space, including locker and wash room, is figured per pupil. For academic work approximately 18 square feet of floor space per pupil is figured. In the drawing room 45 square feet per pupil is allotted — this, however, including supply room and blue-print room. Classrooms are in the shops for shop subjects, and apart from the shops for cultural and related subjects.

The trades taught are: Agriculture, including a practical and scientific course in dairying, horticulture, and general farming; carpentry, bricklaying, including range, furnace, and boiler setting, etc.; the machine trade in its usual details; operating engineering, including care of steam and electrical appliances, steam fitting, etc.; and pattern making. The shops are well equipped for trade teaching.

FIG. 142. — AGRICULTURAL BUILDING, FREE SCHOOL OF MECHANICAL TRADES, WILLIAMSON, PENNSYLVANIA.

The value of this equipment is given as: Machinist's trade, $26,000; carpentry, $8320; pattern-making trade, $12,870; bricklaying, $3100; operating engineering, $27,690; scientific agriculture, $27,300; total, $116,280. Operating engineering students receive their practical training in the steam and electrical plant of the institution, which provides all heat, light, and power needed. Each scholar takes but one of the trades mentioned.

Requirements for Admission. — Graduates of the Williamson School have a reputation for thoroughness, and as high as 98 per cent of the members of a graduating class have immediately started as journeymen at the trades taught them. Admissions are made in April of each year, and first preference is given to boys from Philadelphia, or Bucks, Montgomery, and Delaware Counties, Pa.; second to those from elsewhere in the state; third to those from New Jersey; and finally to applicants born elsewhere in the United States. None but natives of the United States are eligible for admission. Candidates must be not less than 16 nor more than 18 years of age, healthy, able-bodied, possessed of natural aptitude and liking for mechanical or agricultural work. They must have sufficient education to enter readily upon the school work.

Applications for admission considerably exceed capacity and there is a waiting list, for which boys of not less than 15 years of age and upward and who will not be more than 18 at the next admission period may qualify.

Students Are Indentured. — A preliminary trial is given applicants, and those who are found satisfactory are bound to the trustees as indentured apprentices for a term of three years. This indenture may be canceled by the trustees at any time for incompetency, bad conduct, or reasons compelling the conclusion that a boy is undesirable for future support and education. The scholars, by the indenture, are obligated to conform to all regulations and restrictions of the board of trustees or their representatives; and all right of claim to control them during the period they remain at the school is lodged with the trustees.

Miscellaneous Data. — The school can accommodate about 250 students. Their life is made to conform as far as possible to good family standards in so far as living quarters are concerned. The boys are divided into families of 24, each having its matron and its own distinct home or cottage, cared for by its occupants. These homes contain no kitchens, dining rooms, or laundries. These, as well as the dining hall, are located in other buildings. Special attention is paid to the moral training of the students. The school is nonsectarian, but each student is required on entrance to designate his denominational preference and thereafter to attend service regularly at its nearest place of worship. A four weeks' vacation in summer and short vacations at Easter, Fourth of July, Thanksgiving, and Christmas are given to students deserving them.

The Lathrop School of Mechanical Trades, Kansas City, Mo. History and Location. — The Lathrop School of Mechanical Trades — a part of the public-school system of Kansas City, Mo. — was organized in 1911 as a boys' industrial school, and continued as such until 1916, when it was reorganized into a trade school. It was housed first in an old brick school building erected in 1900. The site is well located, is accessible by car lines from all parts of the city, has ample natural light and ventilation, and is not overshadowed or crowded by adjacent buildings. The ground is 277 by 168 feet, and the buildings cover about 75 per cent of this area.

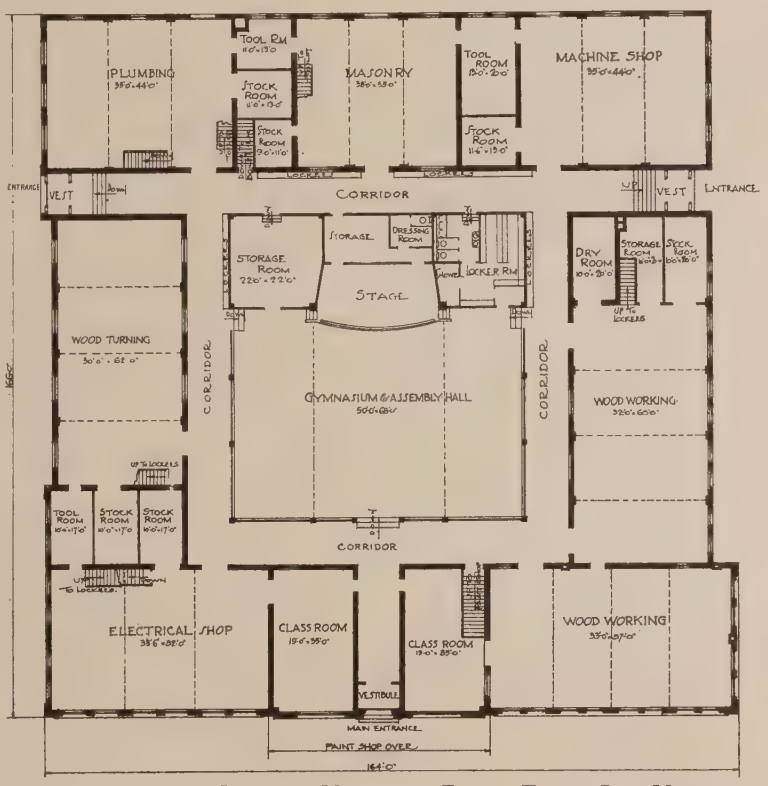


FIG. 143. — LATHROP SCHOOL OF MECHANICAL TRADES, KANSAS CITY, MISSOURI.

Buildings. — In addition to the old main building, a new shop building of modern factory type is being constructed in units by the pupils in the Building

Trades Classes. The first of these was completed in 1916 and the second in 1917. Further extensions will be erected as needed. Both are constructed of brick, with permanent plastered partitions. The total value of buildings is inventoried at $91,000, not including value of the site.

Equipment and Courses. — The equipment is valued at: Cabinetmaking, $3300; electricity, $1000; plumbing, $350; painting, $300; printing, $3500; carpentry, $200; sheet metal, $600; total, $9250.

The minimum age requirement for entrance is 14 years for all courses, and each trade requires 2 years of 40 weeks each.

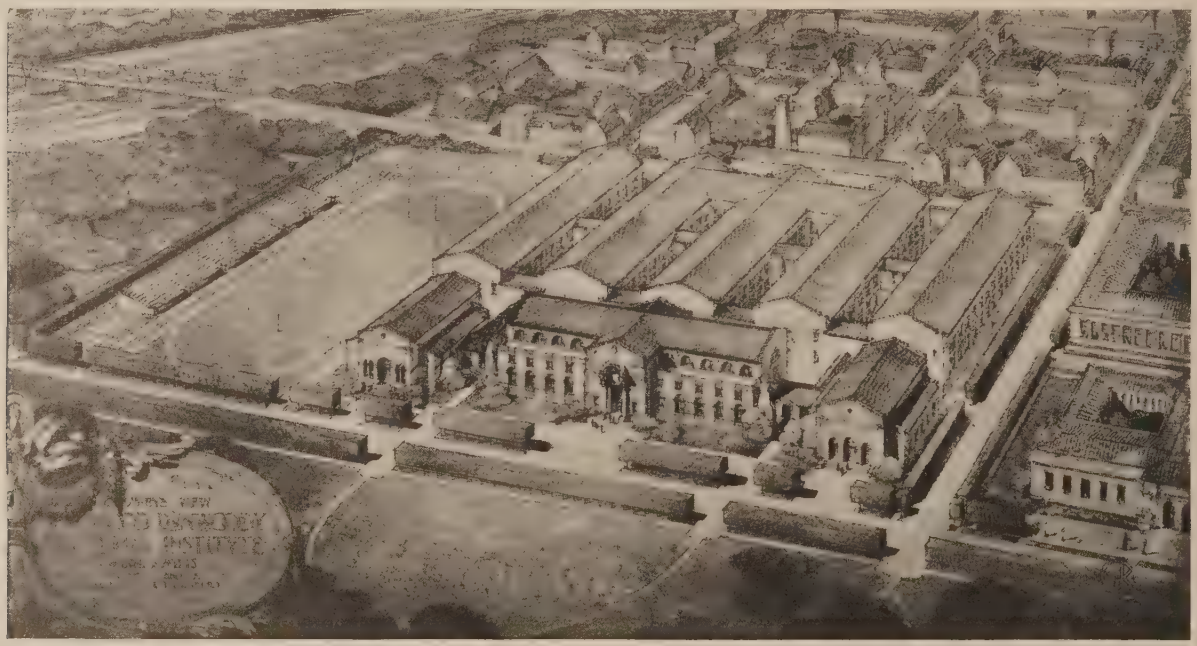


Fig. 144. — William Hood Dunwoody Industrial Institute, Minneapolis, Minnesota.

In the evening school electricity, sign writing, cabinetmaking, printing, and sheet-metal working are taught. Two terms of 35 nights each are required per year. Part-time school instruction is given in printing.

Miscellaneous Data. — The capacity of the school is given as follows in the various courses: Electricity, 24; carpentry, 24; plumbing, 12; painting, 24; sheet-metal working, 24; total, 162. Enrollment March 1, 1918, was reported as: Plumbing, 5; sheet-metal working, 8; advanced electricity, 24; cabinetmaking, 14; wood turning, 16; printing, 10; painting, 15; elementary electricity, 15; carpentry, 14; and 4 men in the evening printing class; total, 125 pupils.

The William Hood Dunwoody Industrial Institute, Minneapolis, Minn. History and Location. — By the will of Mr. William Hood Dunwoody, a wealthy flour manufacturer, who died February 8, 1914, approximately $3,000,000 was devised for the purpose of establishing an industrial school which should be free, without restriction of race or color, to all residents of the state of Minnesota and the city of Minneapolis. Twelve trustees were designated by the will to start the work of carrying out the desire of the donor. They met and organized themselves into a corporation. The school opened in December, 1914, with a registration of 80 students in four trades. The quarters occupied were temporary. In 1915 Mrs. Dunwoody died, and by her will left an additional $2,000,000 to the school, thus bringing the endowment total to $5,000,000.

The trustees bought a 15-acre tract fronting on the parade grounds, in Minneapolis, upon which to construct the buildings and plant of the new institution, which it was planned to make as near ideal as possible. The site conforms to the ideal. It is sufficiently large for present and future needs, located centrally, accessible to good street car service, and in a good neighborhood. It is in close proximity to a public playground, and there is no possibility of the maximum of natural light and ventilation being interfered with.

When work began in December, 1914, there were 80 students and four trades or occupations taught. In January, 1915, the number of trades was increased to seven and the enrollment to 175. The present enrollment is in excess of 650 and the capacity 1350, with lists of subjects taught as given below.

In September, 1915, the day-school enrollment was increased to 250; and in October a night school of approximately 1500 men was started. Dull season, part-

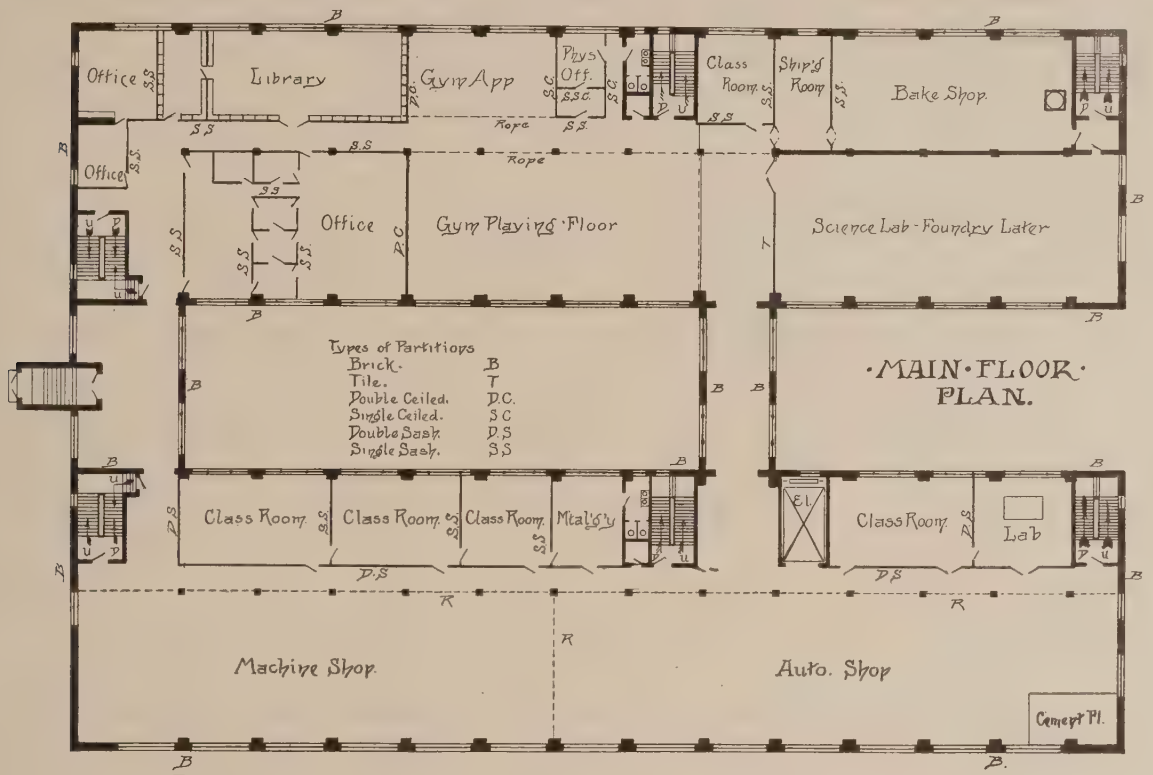


FIG. 145. — WILLIAM HOOD DUNWOODY INDUSTRIAL INSTITUTE, MINNEAPOLIS, MINNESOTA.

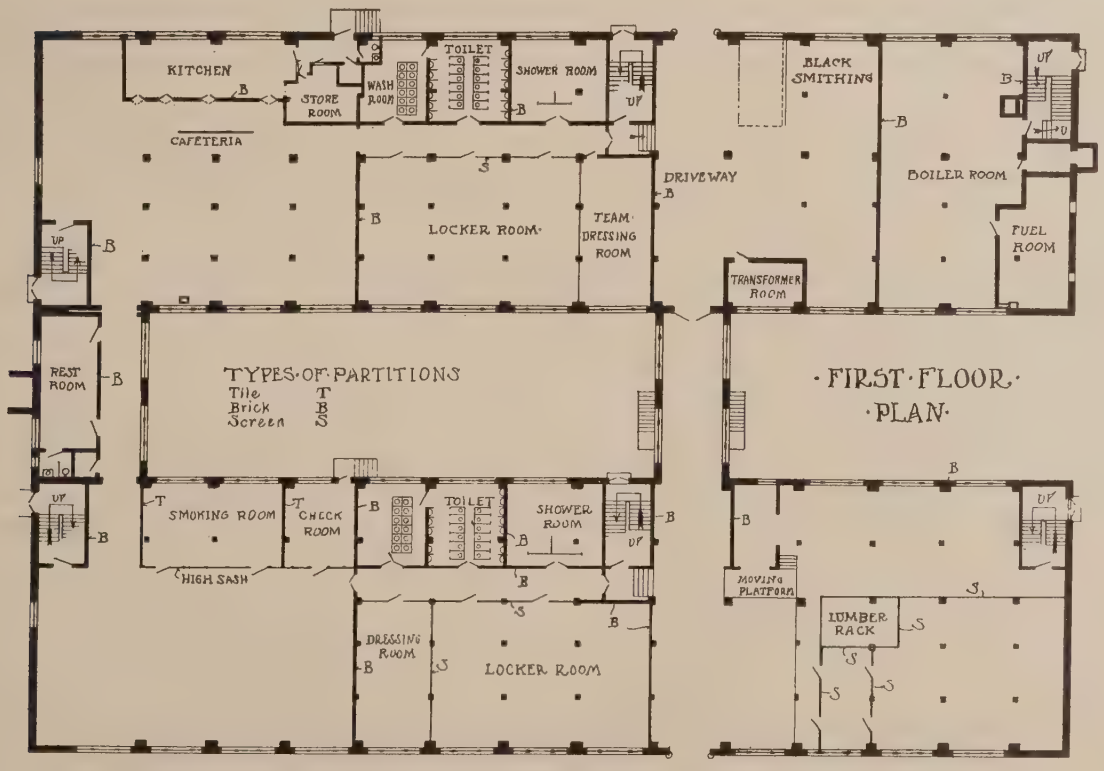


FIG. 146. — WILLIAM HOOD DUNWOODY INDUSTRIAL INSTITUTE, MINNEAPOLIS, MINNESOTA.

time, and extension classes were started in the winter of 1915–1916. Recruiting men in the Enlisted Reserve and war training began at Dunwoody in April, 1917. The school moved into its new quarters August 1, 1917.

During the war all the regular peace-time activities of the school were continued on approximately the same basis as before the war; all war work was taken on in addition. The war work included training of enlisted men in the navy and army for trade, and the mechanical occupations. It also included the training of conscripted men in both day and evening school work.

by two passageways on each floor, one at the front of the buildings and one at approximately the center. Future plans for expansion call for four more shop units, an auditorium, administration building, gymnasium, and power house. A set of sketches has been made for the complete plan of 10 buildings and athletic field, equipment for them to be provided in accordance with the industrial demands of the state.

Equipment and Courses. — Present equipment is valued at: Automobile department, $10,000; baking and laboratory, $30,000; aeroplane department, $10,500; machine shop, $30,000; power laboratory,

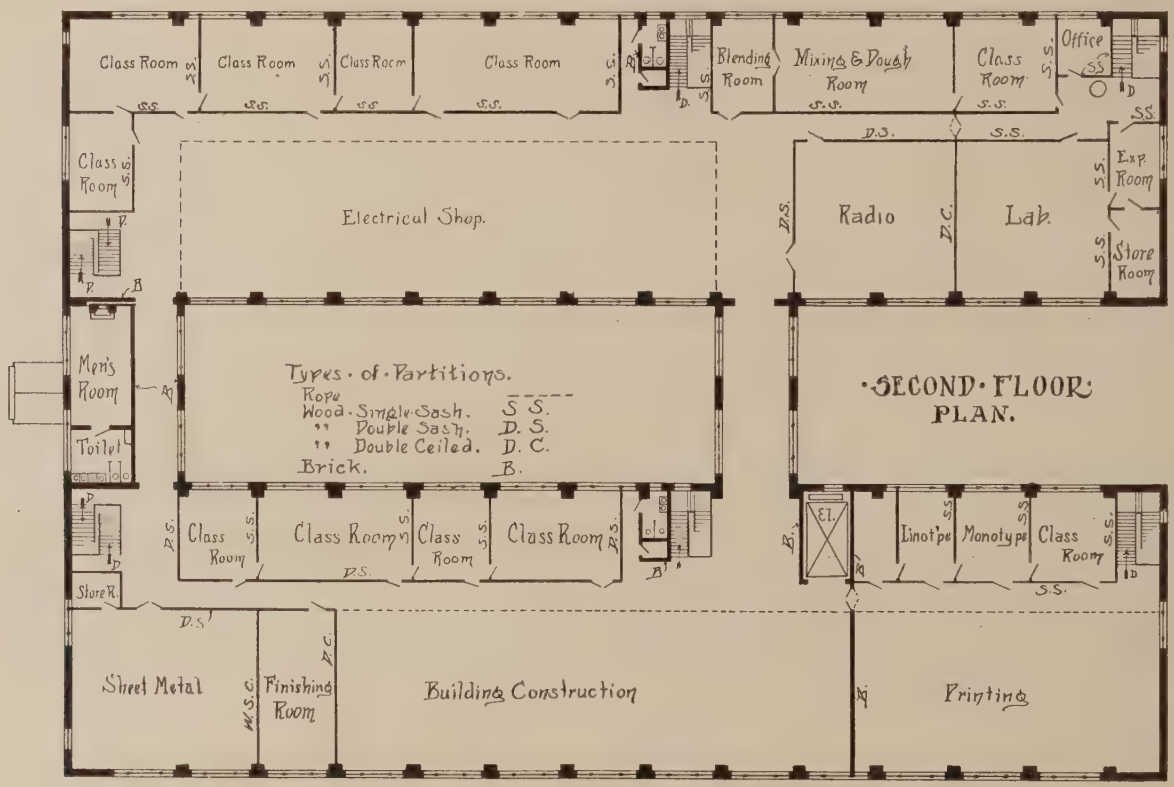


FIG. 147. — WILLIAM HOOD DUNWOODY INDUSTRIAL INSTITUTE, MINNEAPOLIS, MINNESOTA.

Buildings. — The new, especially designed buildings of the institute were completed in 1917 and are now occupied and in use. There are two units of reinforced concrete with brick facings, each 75 feet wide by 285 feet long, two stories high, with full basement. A total of 125,000 square feet of floor space is thus obtained, equivalent to a six-story building 75 feet wide and 285 feet long. Partitions are of wood and glass, temporarily placed as necessities require; fireproof paint is used and the structures are made fireproof. Creosoted paving blocks are used as flooring. There are 27 classrooms, in which over 800 students can be given instruction. The classrooms are used for recitation and study purposes. The two parallel buildings are connected

$15,000; woodworking department, $10,000; total, $141,500.

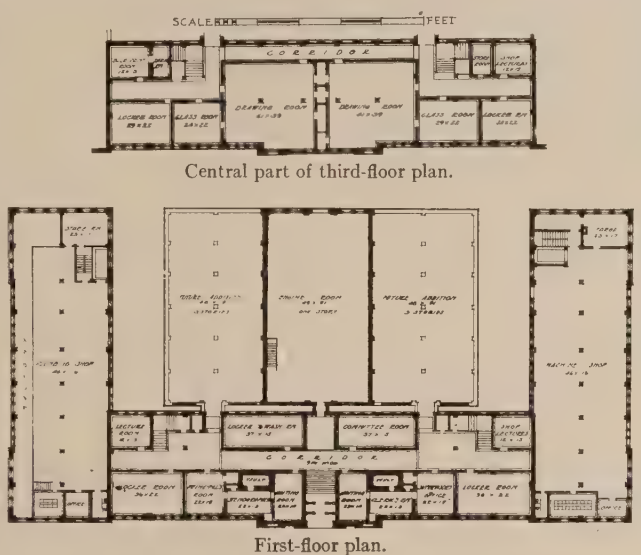
The day courses offered by the school are: Automobile work, baking, building construction, drawing and design, electricity, gas manufacturing, heat treatment, machine-shop work, plumbing, printing, radio work, sheet-metal trade, slide rule, steam fitting, telephony, welding, aviation motors, cooking, carpenters, coppersmiths, metal workers, blacksmiths, vulcanizing, pilots, quartermasters, machinists' mates, and Liberty motor ignition for the aviation section of the army.

Evening courses are offered in: Automobile repair and construction, building construction (including carpentry, mill-room work, building foreman, cost esti-

mating, and concrete construction), electricity (general), gas manufacture, heat treatment, plumbing, printing (composition, press work, and linotype work), sheet metal, slide rule, steam fitting, and telephony. These courses are divided into short units of 14 to 30 lessons each.

Evening courses running through the entire evening-school term of 50 lessons are: Baking, drawing and design, building-construction drafting, sheet-metal drafting, interior decorating, machine drafting and design, machine-shop subjects, welding.

Evening-school courses are arranged on a basis of two hours per night, two nights per week. Shop courses are arranged four hours per night, one night per week. The length of the evening-school season is 25 weeks, or a total of 100 hours. The units in practically all classes are arranged to cover a period of from two to three years. A certificate is issued upon the completion of any unit; a diploma is issued upon the completion of all units in a course.



Central part of third-floor plan.

First-floor plan.

FIG. 148. — PLANS OF BOYS' TECHNICAL HIGH SCHOOL, MILWAUKEE, WIS.

Boys' Technical High School, Milwaukee, Wis. History and Location. — In January, 1906, some philanthropic citizens interested in vocational education founded the Milwaukee School of Trades. The institution, by act of the Wisconsin Legislature, was taken in and became a part of the public-school system of the city of Milwaukee, July 1, 1907, and on May 1, 1917, the name was changed to "The Boys' Technical High School."

The site is centrally located in a district partly residential. It is 314 by 158 feet, and so situated that the natural light and ventilation are not obstructed, overshadowed, or interfered with by adjacent buildings. It is near the manufacturing center of the city, and is accessible by eight car lines from different parts of the community, and the general environment is good.

Buildings. — The buildings occupied were erected for the purpose of a technical high and trade school in 1911–1912. In 1915 the administration building was put up, and in 1917–1918 the new west wing was constructed. The buildings are of reënforced concrete, faced with brick, and with hollow-tile partitions; the flooring, except in corridors, is of wood, and the buildings are lighted by electricity. Calculation of floor space is made on a basis of equipment. Contemplated expansion is designed to afford quarters to house the printing department and equipment, as well as the automobile department and its equipment. A new "East-wing" building is also being planned. The value of buildings is given as $300,000.

Equipment and Courses. — Equipment is inventoried as follows: Machine and tool making, $50,000; for the pattern-making trade, $8000; electricians' trade, $6500; telegraphy, $550; carpentry and cabinetmaking trade, $9600; plumbing and gas-fitting trade, $8000; mechanical-drafting trade, $1500; architectural drafting, $1500; total, $85,650.

The minimum age requirement is 16 years. Tuition is free to residents of Milwaukee under 20 years of age, except that a breakage fee of $5 is required as a deposit. Non-resident students pay $4 tuition per month, as do resident pupils over 20 years of age. The "technical-high" course requires six years, and the trade courses two years each to complete, with an average of eight hours per day for each student. No extension work is given.

The courses consist of preparation for the following trades: Machines and tool making, pattern making, electrician, telegraphy, carpentry, cabinetmaking, plumbing and gas fitting, mechanical drafting, and architectural drafting.

The day sessions open in September and close in June. Evening instruction is given three times a week from October 1 to May 1 in all of the above-mentioned subjects. When 24 regular students whose individual programs permit of it sign a petition requesting a subject regularly provided in other Milwaukee high schools, that subject may be offered in the technical high school. Mechanical and free-hand drawing are taught in connection with all shop courses, and at all times each student's program shall include at least one shop course. Persons desiring to obtain a trade diploma in less than four years, work full 8 hours per day, 40 hours per week.

Miscellaneous Data. — The enrollment of pupils in 1918 was: Day classes, 172; night classes, 244. The

FIG. 149. — VOCATIONAL SCHOOL, NEW BEDFORD, MASS.

management states that by employing additional instructors and using the shops to full capacity 470 pupils could be accommodated in day work and the same number for the night classes.

The school does not claim to turn out journeymen mechanics. Its aim is to instruct students thoroughly in as short a time as possible in all the fundamental principles and in practice of the trade in question. In this way the pupils upon graduation possess ability and confidence and are of immediate practical value to their employers and receive a fair wage at once.

The New Bedford Vocational School, New Bedford, Mass. History and Location. — The New Bedford Vocational School is part of the Massachusetts public-school system. It was first opened in 1908, and has proved a very successful venture in practical education.

The site is 166 by 170 feet, located in an industrial district in the center of the city. Natural light and ventilation are not obstructed by adjacent buildings. The site was chosen on account of its accessibility by car lines and of its situation in an industrial district.

Buildings. — The type of the main building is an old frame factory building, rented in 1910. Some additions have been made to the plant since the building was taken over: a two-story frame building to house the gas producer, a two-story addition 20 by 24 feet for the power plant, and in 1915 a three-story addition for tool and locker rooms for machine and carpentry departments. Floorings are of wood and concrete. The building has been converted to the present use so that it is serviceable, even if lacking in many respects. It is lighted by electricity. Classrooms are apart from the shops. Floor space per pupil has not been calculated, owing to the makeshift character of buildings.

Equipment and Courses. — The value of equipment of the institution is given as follows: Machine shop, $19,000; carpenter shop, $3000; power departments, $11,000; electric department, $4000; homemaking department, $5000; total, $42,000.

Capacity of school is given as follows: Machinery pupils, 36; carpentry, 45; electrical, 36; steam engineering, 20; homemaking, 45; a total of 182 pupils.

Number of pupils March 1, 1918, were: Machinery, day class 31, night 24; carpentry, day 8, night 12; electrical, day 32, night 50; steam power, day 10, night 32; homemaking, day 32, night 502; total, day students 113, night 620. There are 81 pupils in the part-time homemaking course.

Painting and decorating are to be added in the near future to the day courses. Evening classes for women are being conducted in seven sections of the city, and this extension work is scheduled for amplification.

The steam-power course is three years, as is the "homemaking" course. Machinery, carpentry, and

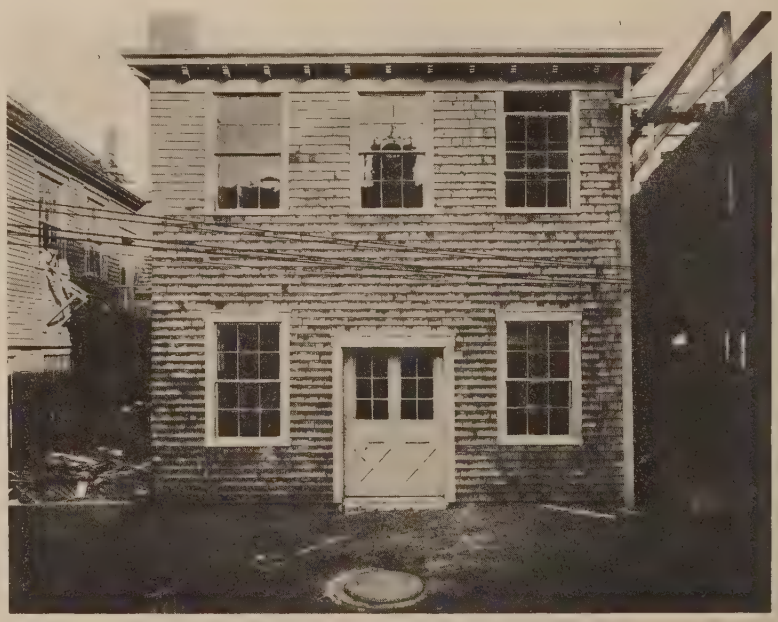


FIG. 150. — VOCATIONAL SCHOOL, NEW BEDFORD, MASS.

electricity require four years each. There are 40 weeks in the school year, and forty courses are required, for machinists, carpentry, steam engineering, sheet-metal drafting, mechanical drawing, machinery, mathematics, carpentry, shop drawing, sewing, cooking, and millinery.

The Bayonne Vocational School, Bayonne, N. J. History and Location. — The Bayonne Vocational School was organized September, 1911, by the board of education of the city of Bayonne. It is a public school, half the cost of support being paid by the municipality, the other half by the state. The location of the school is accessible from all parts of the community.

The function of the school is to train boys to enter the industries of the community with some definite preparation for earning a living. It does not aim to turn out journeyman mechanics, but to ascertain what trade a boy is best fitted to follow, and then to give him such a foundation as will fit him to enter that trade as a superior apprentice.

Buildings. — The main building of the school plant was erected about 1875 as a Y. M. C. A. structure. It was remodeled for a high school about 1908, and again remodeled in 1911–1912 for occupancy and used as a vocational trade school. It is of three-story brick, with brick partitions. There is a frame annex of two stories, built for a high school, and in 1917 a one-story concrete base and maple-floored extension to the mechanical shop was constructed. This building is 30 by 60 feet, and brings the total machine-shop area to 3600 square feet. Classrooms are apart from the shops. The total value of buildings is given as $23,000.

Equipment and Courses. — The value of equipment totals $35,000, apportioned as follows: Machine shops, $28,000; woodworking, $2000; electric wiring, $2500; printing, $1700; mechanical and academic drawing, $700.

The capacity of the machine shop is for 40 students at one time: Woodworking, 24; electric wiring, 24; printing, 24; and mechanical drawing, 24.

Fig. 151. — Vocational School, Bayonne, New Jersey.

The daily program requires three hours of shopwork, two hours of academic work (arithmetic, history, English, etc.), and one hour of mechanical drawing, making a school day of six hours.

Employers of Bayonne make frequent calls upon the institution for boys to enter their industries, and the number of calls has been greater than the school has been able to supply. The school has graduated 69 boys, over 90 per cent of whom are engaged in the trades for which they were trained.

The minimum age for entrance is 14 years. A boy who has completed the eight grades in the elementary schools can graduate from the vocational school in two years; otherwise three years is required. Special academic work is provided for pupils who are not graduates of the elementary schools. There are 40 weeks in the school year for the day school, and a minimum term of 64 nights per year in the evening school, in which instruction in machine-shop work, pattern making,

carpentry, electric wiring, and mechanical drawing is provided. No extension work is given. The school has enrolled over 900 pupils in the day courses. In the evening schools over 1000 men have received technical instruction definitely related to their daily occupations.

FIG. 152. — WENTWORTH INSTITUTE, BOSTON, MASS.

Shop instruction is individual as far as possible, thus permitting each pupil to progress as rapidly as he is capable of doing. Graduation is based upon proficiency in the shop, rather than the academic course.

Wentworth Institute, Boston, Mass. General Plan. — The buildings of Wentworth Institute which have already been erected (those shown in figure 152, excepting the power plant in the rear of them) form merely a façade group of the great system of buildings which the directors have in mind for the future. It is hoped to build back over the grounds to the rear a plant which shall have, at its smallest, the size and arrangement indicated in figure 153.

The conditions which will control this development are the needs of the youth and of the industries of the community, with the emphasis in one decade on one kind of work and on another in the next, and the introduction of new trades or the revision of old ones by new progress in methods. The approach from the parkway opposite will be kept impressive, and the administration buildings will always be conveniently located near the center of the group.

Flexibility of Plan for Buildings. — To meet these conditions of development the plan for buildings has had as its first requirement flexibility. This flexibility was gained by adopting a standard building "*unit*" which may be repeated again and again in various locations upon the grounds without sacrificing symmetry, convenience of arrangement, or of connection between buildings.

A great variety of types of buildings was carefully studied. The advantages and disadvantages of each were considered. Finally, there was adopted a three-and-one-half-story and basement building, 48 feet wide by 144 feet long, divided into nine equal bays of 16 feet each. The width of the building is equal to the length of three bays. The flexibility of the scheme results

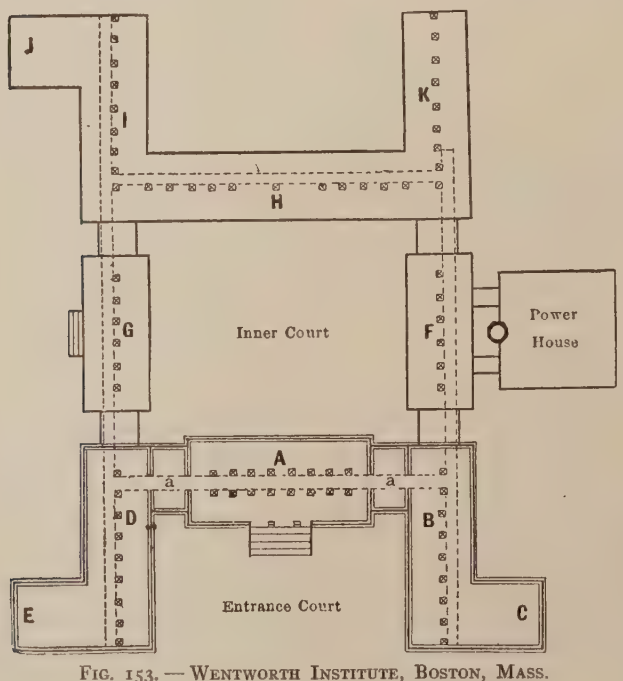


FIG. 153. — WENTWORTH INSTITUTE, BOSTON, MASS.

FIG. 154. — STANDARD UNIT DIVIDED FOR INSTRUCTION IN SHOPS, WENTWORTH INSTITUTE.

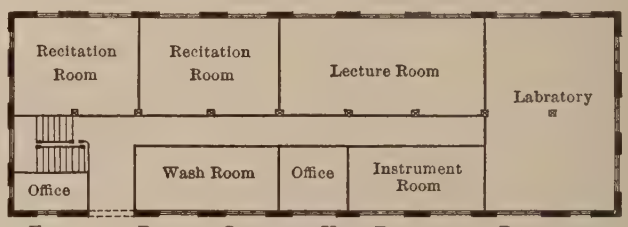


FIG. 155. — PLAN OF STANDARD UNIT DIVIDED FOR RECITATION ROOMS, WENTWORTH INSTITUTE.

FIG. 156. — PLAN OF STANDARD UNIT ARRANGED IN A SPECIAL COMBINATION, WENTWORTH INSTITUTE.

not only from the previous knowledge of the size of the units to be erected in any relation to any buildings already erected, so that a unit or two can be omitted and building proceed at a distance, if necessary, but it results mainly from the dimensions themselves, for the width being one-third of the nine-bay length permits a development into a T-shaped building by adding a standard unit or a double unit as a wing in the center of the rear, or it permits a U-shaped building to be developed by extending wings of single or double units at the rear of either end. These T and U structures may, in turn, be developed into rectangular buildings about a single or double central court. These possibilities are revealed by figure 153. The nine bays also make it possible to have either one entrance in the center of the building,

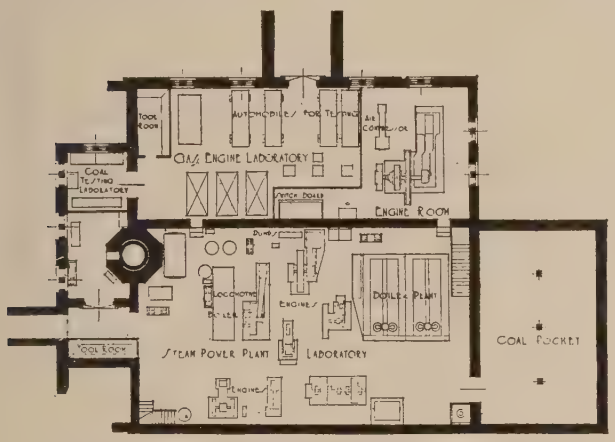


FIG. 157. — FLOOR PLAN OF POWER PLANT LABORATORY, WENTWORTH INSTITUTE.

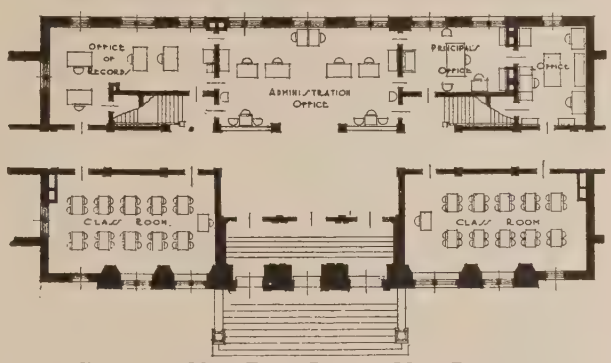


FIG. 158. — MAIN FLOOR PLAN OF MAIN BUILDING, WENTWORTH INSTITUTE.

or two entrances symmetrically located near either end, without having a column on the axis of the entrance.

In the case of Wentworth Institute sufficient room has been provided on all sides of the group of buildings now erected to permit extension in any direction; for example, the wing B, in figure 153, can be extended in length forward for 96 feet. It can then have a second and third wing parallel to the wing C extended at either end of it for a distance of 96 feet; and these two wings may be connected in the rear by another building running parallel to B, forming a complete rectangle such as has already been mentioned, with two courts 48 feet square. Should all of these additions be made to this section the completed structure would have a floor space equal to four and one-third of the standard units adopted. It is, of course, not necessary to complete the whole group, nor indeed to add the units in any very definite order. The great variety of ways in which the growth can take place shows the flexibility of the plan.

Connecting the Units of Building. — When the standard units are juxtaposed in the development of a court group of buildings no connecting links are necessary. But between such groups and simple units such as, for example, A and B in figure 153, connection must be supplied. At Wentworth Institute this is secured by a 12-foot covered passageway on the first floor and also in the basement, between adjoining buildings (figure 153). The buildings are not connected on other floors. Thus neither lighting nor outlook has been appreciably impaired, nor has the architectural outline been destroyed. On the other hand, the covered passageway permits the centralization of washrooms, locker rooms, study rooms, etc.; makes it unnecessary to face the weather in going from building to building; reduces the distance from department to department; and facilitates administrative relationships among departments and between departments and the general offices. By the same means central control of the student body is assured. Students cannot enter or leave the buildings without passing the general offices in the main building. They are obliged to pass the bulletin boards at least twice daily. Habitual tardiness is easily observed and corrected and in many other ways more effective and efficient control is obtained than would be possible in buildings separated in the usual way.

Special Advantages of the Standard Unit Adopted. — The standard unit adopted is arranged for natural ventilation through outside transoms, glass areas, etc. The buildings, therefore, are not dependent for fresh air upon an intricate ventilating system, which is subject to faulty operation; nor is there danger of having at some time an ill-ventilated building, because the system is too expensive to operate, as in the cases of several recent educational structures.

The dimensions of the unit involve a building with a single row of columns down the center (figure 154). The double row is the plan upon which almost all school buildings are laid out. This common method permits a wider structure than the single row of columns used at Wentworth Institute. But the results are all in favor

of the narrower building. A single row of supports gives as wide a floor space as can be perfectly lighted from the windows; the double row gives an area too wide for good lighting. The double row clutters the area with a forest of pillars, making general observation difficult over any large room and hampering the arrangement and movement of equipment. Moreover, the single row of supports, permitting a unit of 48 feet wide by 144 feet long, carries floor area which will admit the selection of a maximum standard size of shop or laboratory. This maximum standard is based upon the distance over which an instructor can control a group of students without unnecessary movement about the room for purposes of observation and discipline. This standard shop is in the general proportion of 50 by 100 feet.

FIG. 159. — GROUND-FLOOR, WEST BUILDING, WENTWORTH INSTITUTE.

FIG. 160. — FIRST FLOOR, WEST BUILDING, WENTWORTH INSTITUTE.

Among the advantages which accrue from the adoption of any standard unit is that of easy and simple adjustment of departments when, in the process of growth or reorganization, they are moved from building to building. Furniture, machines, all equipment which fitted in one shop will fit in another of the same proportions. The equipment which stood in a certain corner can easily be disposed in the new quarters in an analogous corner. The economy of time and effort which is made in this regard is as important as the economy of funds through not having to purchase substitute equipment. This is a very considerable saving. Wentworth Institute has had several occasions to test it. The adjustment of the plant to the housing and instruction of the training detachment of soldiers has been one instance. And when each additional building was finished the expansion involved a similar adjustment. For instance, the drafting courses' equipment was once all in the west building; then all of it was moved to the main building; later part was moved on to the east building, when that was completed. Every piece fits in its new place and no substitution purchases have been necessary.

Expansion and readjustment are further simplified by the fact that all partitions except those covering stairways are removable, though soundproof, and all rooms may be thus decreased or increased in size to suit immediate uses. By this scheme fitness alone need be consulted in placing departments in new quarters in another building. If the floor best suited for a certain department which uses a large shop formerly housed a group of recitation rooms and offices, the temporary partitions form no obstacle to placing that department on that floor. (Compare figure 154 and figure 155.) By virtue of this removability of partitions the arrangement not only of the departments with relation to one another but within the department becomes highly flexible and makes it possible for the institute to set a high standard in efficient use of floor space and in its plan for simple and direct travel of materials and workers.

The Arrangement of the Standard Unit Floor. — The standard unit may be divided for instruction in shop practice (figure 154) or it may be divided for recitation rooms, lecture rooms, etc. (figure 155). Where large shops or large laboratories or drawing rooms are required, the full width of the building is used, and the rooms may be 32 feet, 48 feet, 64 feet, 80 feet, 96 feet, or 112 feet long, as desired. When recitation or lecture rooms are required, a corridor about 8 feet wide is run on one side of the center row of columns, making rooms 24 feet wide on one side of the building, and about 15 or

16 feet wide on the other. Recitation or lecture rooms are naturally made 24 by 32 feet or 24 by 48 feet. Both of these are very convenient sizes. The narrow space on the other side of the corridor, too, divides itself readily into offices 16 feet square, or instrument rooms, washrooms, etc., 16 by 32 feet, or 16 by 48 feet. It would be difficult to select dimensions for a standard building which could be divided more readily into rooms of convenient sizes for all sorts of purposes, or in more convenient combinations.

General Review of Buildings. — The buildings of Wentworth Institute may be conveniently designated as the west building (right of photograph, figure 152), main building, east building (left of photograph, figure 152), and the power-plant laboratory. Of these the west building and the power plant were finished when the school opened in 1911; the main building was completed in 1914; and the east building in 1916.

The steam power plant laboratory is about 80 feet square and is located to the rear of the façade group (figure 153).

The main building is 132 feet long by 66 feet wide. It contains in the basement a large laboratory about 60 feet square, with adjoining offices, for electrical-power practice and work in electrical construction, a second large laboratory for architectural construction, and a large locker room and a wash room. On the main floor are two large lecture rooms and the administration offices. The entire second floor is devoted to construction in mechanical and architectural drawing and design. On the third floor is an assembly hall and gallery. The remainder of the third floor and gallery is occupied by laboratories, stock rooms, and offices for instruction in applied science and practical mechanics.

The west building is chiefly a shop building, 145 feet long by 49 feet wide, with four high-posted stories and a well-lighted gallery floor for workshops, laboratories, and classrooms; and a small one-story wing extending to the south for offices, which serves also as the passageway to and from the main building. In this building are, on the top story, a large shop for electric wiring, a plumbing shop; a pattern shop, with stock rooms, tool room, offices, etc., occupies the whole of the second floor; a machine shop of equal size and somewhat similar appointments occupies the first floor; below are a foundry and finishing room, with rooms for pattern storage and supplies, occupying a floor space over 50 by 100 feet. There is also a gallery floor for cupola charging, core making, brass molding, and metal-pattern making; two laboratories for industrial chemistry; a blacksmith's shop and a hardening plant; and a large lecture room and three smaller rooms for class exercises and recitations.

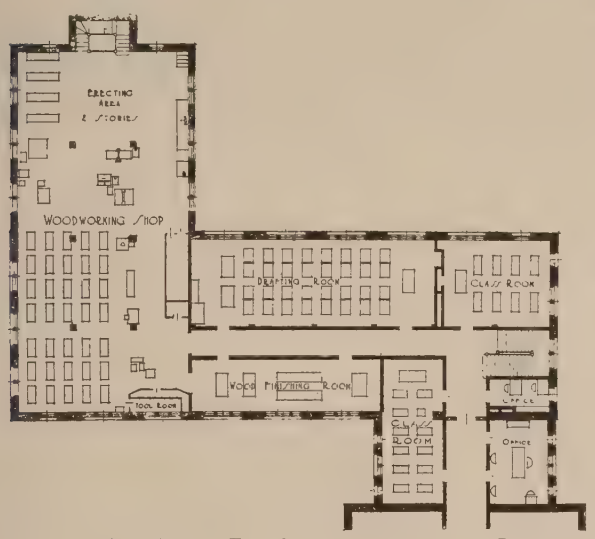


FIG. 161. — FIRST FLOOR, EAST BUILDING, WENTWORTH INSTITUTE.

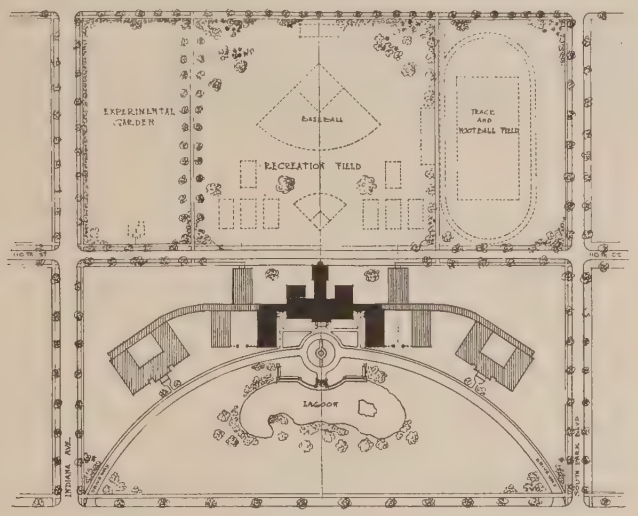


FIG. 162. — PULLMAN FREE SCHOOL OF MANUAL TRAINING, PULLMAN, ILLINOIS.

The east building, which contains about 45,000 square feet of floor area, provides four additional classrooms, large laboratories for strength of materials, reënforced concrete, and building materials. It also provides two shops for carpentry and house building and three entire floors for the school of printing and the graphic arts.

The Pullman Free School, Pullman, Ill. — The above plan shows the elaborate layout of the Pullman Free School of Manual Training, at Pullman, Illinois. The site is located in South Chicago, and is near many industries as well as near the homes of many working people. The plant occupies a site 1250 feet by 1250 feet, of which about 2 per cent is included in buildings.

FIG. 163. — PULLMAN FREE SCHOOL OF MANUAL TRAINING, PULLMAN, ILLINOIS.

The buildings are situated so as to be well lighted and ventilated. The grounds are arranged to afford athletic and recreational opportunities.

The name of this school was determined by the terms of the will of George M. Pullman. The courses advertised include cabinet making, trimming, pattern making, blacksmithing, molding and casting, machine shop practice, electrical construction and installation, and operative engineering. "To complete any one of the regular courses of instruction," it is declared in the dedicatory announcements, published September, 1916, "will require from four to six years. The school is in session forty-eight weeks of the year for five days each week and for eight hours per day. During the first two years one-half of the time is devoted to academic studies, including English, history and mathematics; the other half to drawing, shopwork, and laboratory work. With young women, shopwork is replaced by work in cooking and sewing."

The Boys' Vocational School, — Newark, New Jersey. History and Development. — The Boys' Vocational School of Newark was established in April, 1910, as an elementary industrial school, with an initial enrollment of forty boys. Instruction was given in woodwork, mechanical drawing, and complementary academic subjects.

So vital was the need, as demonstrated, for an institution of the sort, that in September, 1910, the school was enlarged to accommodate 100 boys. A course in metal working was added. In September, 1911, courses in electric wiring and printing were included in the curriculum. In 1914 a further expansion was made, to accommodate an additional 40 pupils. A later rearrangement enabled the school to have eight classes and take care of 160 pupils, at which the capacity has remained. A waiting list of applicants averages 180 pupils. This number was 250 in April, 1918.

The school was established for boys who through necessity or otherwise chose to enter the industrial field at about the age of sixteen, and who have shown ability for mechanical work. The main object of the school is to prepare boys for apprenticeship to the mechanical trades, and is in no way intended as a preparatory school for the technical high schools, although the course of study is so arranged that entrance to the technical high school may be had at the completion of the course. While a pupil receives a thorough preparation in trade work,

FIG. 164. — WOOD-WORKING AND FORGE SHOP, PULLMAN FREE SCHOOL, PULLMAN, ILLINOIS.

the academic side is thorough also. Applicants must have completed five years of grammar school work, have in mind preparation for a mechanical trade and express a willingness to complete the three years' course. Promotions are made by subjects and not by grades.

Present Location — Equipment — Courses. — The first home of the school was in an old building owned by the Board of Education, and remodeled for vocational purposes in 1910. The shop building was erected in 1848 as an elementary school. The academic department is in an elementary school erected in 1908. The buildings are of brick, electric lighted, wood floors, no partitions, and the whole a makeshift.

Equipment for the various trade subjects taught is inventoried as: Electricity, $1200; printing, $2000; machine work, $6500; woodwork, $2500; drafting, $1000; total, $13,200. Value of buildings, $12,000.

Minimum age entrance requirement is 13 years and for a trade subject 14 years. A general course is given to all pupils during the first two years, in order to determine the trade for which each is best adapted. The third year is given to specialization in the trade or occupation for which the pupil has shown the greatest aptitude. By this method the occupation best suited to the taste and ability of the pupil is found. The courses in the trades require two years each in electricity, printing, machine work, woodwork, and drafting. There are 48 weeks in the school year, and each course requires 200 sessions. No extension work is done, but evening courses are given. Records of enrollment March 1, 1918, show: electricity, day pupils 46, night 23; printing, day 36, night 17; machine work, day 42, night 35; woodwork, day 36, night 11; drafting, day 10, night 28.

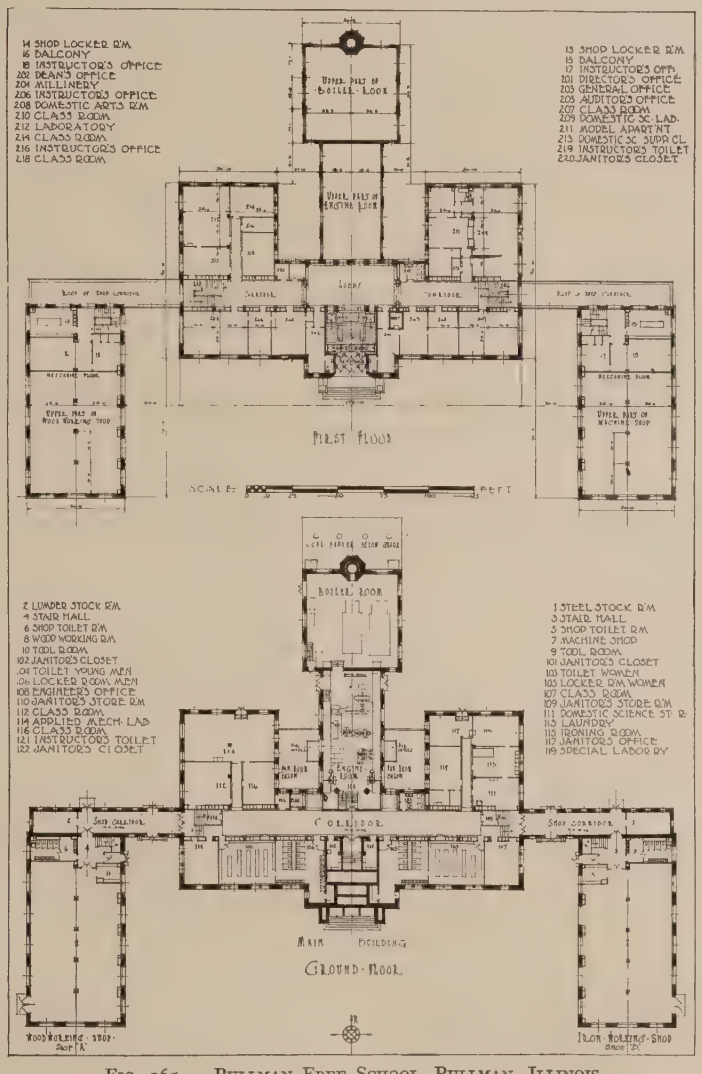


FIG. 165. — PULLMAN FREE SCHOOL, PULLMAN, ILLINOIS.

Placement and Demand for Graduates. — The school makes a practice of placing its graduates in such positions as are considered best for their future welfare. In most cases the salaries are higher than those ordinarily paid non-trained pupils, and in many, the time of apprenticeship is shorter. In 1916, 100 requests were made for graduates by employers, and the school was able to supply only about one-third of the number desired. Numerous requests are made for graduates who have been out of school for one or two years. These changes have invariably resulted in higher wages or promotions for these young men. A Placement Committee, composed of the faculty of the school, attends to this important end of the school work.

Need for Enlargement of Work Demonstrated. — The success of the school caused much attention in business circles in Newark — a most important manufacturing center. The result was a concerted action of business and manufacturing interests, which procured the theme of vocational education in that city to be gone into with great thoroughness. A survey or "overview" of the entire subject was therefore caused to be conducted for the Advisory Committee of the Board of Education, by Mr. Charles H. Winslow, member of the Congressional Committee on National Grants in Aid of Vocational Education, Director of the Vocational Survey of Richmond, Virginia, The Indiana State Survey, etc.

As a result of the report of the Advisory Committee, the Board of Education has taken steps to meet ade-

quately the situation as disclosed, and new buildings are to be constructed, ample for the present and future vocational education needs of the community.

Location and Site of New Buildings. — A site 225 by 241 feet within the industrial center of the city has been chosen for the school. The plant, as projected, will cover 95 per cent of this area. Good car service makes the school accessible from all parts of the city, and natural light and ventilation are not obstructed by adjacent buildings. An inquiry was conducted to locate the present residence of the pupils, and for this purpose the city was divided into four districts. The data obtained indicated that 71.3 per cent of the pupils lived in the section (Sussex Avenue between First and Second Streets) which has been recommended as the proper location.

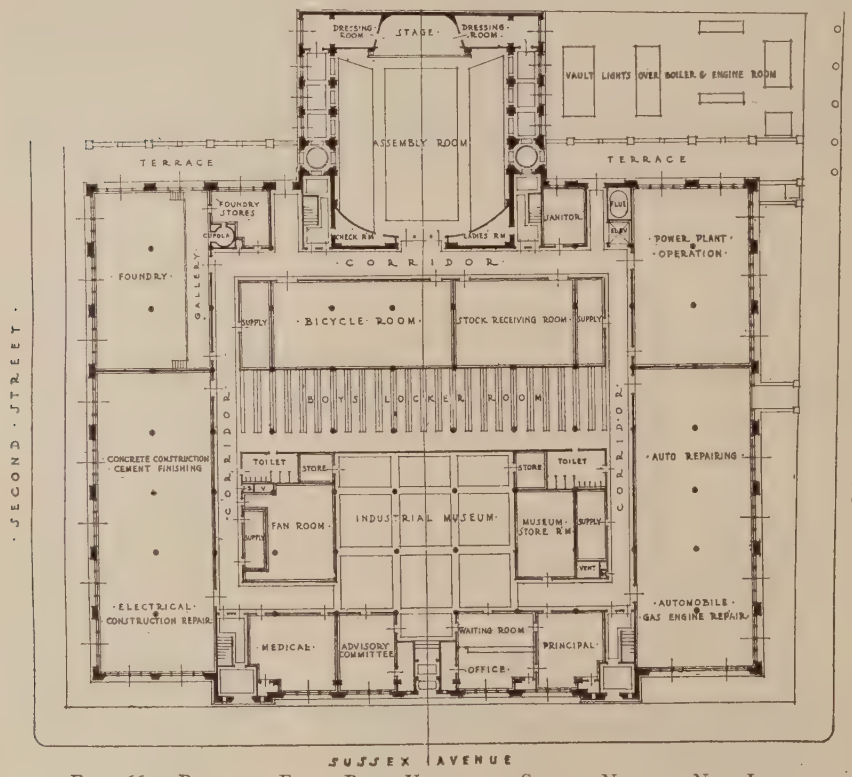


FIG. 166. — BASEMENT FLOOR PLAN, VOCATIONAL SCHOOL, NEWARK, NEW JERSEY.

Type of Building Selected. — Plans drawn for the new school plant show the selection of the reënforced-concrete and steel-sash type of the modern manufacturing plant, with its uniformity of interior construction and subordination of exterior design to the interior structural conditions. Under this form, maximum lighting conditions are thus assured, as well as perfect ventilation and proper square-foot space per pupil.

The plant as designed will accommodate 800 students, and is susceptible of being added to on the unit system as future needs may develop. No effort has been spared to obtain, in the design and arrangement of plan, the most advanced type of practical school construction.

With the new buildings it will be possible to considerably enlarge the number of subjects and trades taught, and to provide for the necessary equipment, its proper housing and installation.

Trade and Industrial Schools for Girls.[1] — The history of the establishment of trade and industrial schools for girls indicates that the cost of buildings and equipment has not figured as a prohibitive factor in the inauguration of these experiments. In fact, considerable ingenuity has marked the transformation of old school buildings, dwellings, factory lofts, and business buildings into shops, and other necessary accommodations for trade schools.

A common type of housing for these prospective schools is found in an abandoned grade or high school building which is remodeled for this purpose. The Trade School in Philadelphia, the Girls' Vocational School in Minneapolis, Minnesota, and in Newark, New Jersey, are of this type.

As the movement for girls' technical and trade schools in communities frequently has its beginning in the activities of philanthropic organizations interested in the social, economic, and educational well being of the working girl, it occasionally receives an estate and housing facilities as a heritage or memorial to the interests of some individual. Such is the case of the Jane Hayes Gates Institute in Kansas City, Missouri. Commodious private homes or dwellings, which were centrally located but which because of the growth of the city have become undesirable as residence property, yet remain unconverted to business purposes, are found housing the Trade School for Girls both in Boston and Worcester.

Some of the schools have undergone shifts from one type of building to another in adjusting themselves to an increasing enrollment. A business building in a down town district has certain desirable features and has been used both in Philadelphia, New York, and New Britain, Conn.

[1] The writer is indebted to Mrs. Anna L. Burdick, Special Agent for Trade or Industrial Education for Girls and Women, Federal Board for Vocational Education, for this description.

The Francis Nicholls School in New Orleans was built for a ward school, but was made an Industrial School on petition of the residents of the district. It was opened as a Trade School, September 24, 1912. The new Manhattan Trade School alone was opened for the purpose for which it was built — that is, trade training for girls.

In such classes as dressmaking and millinery, equipment should be adapted to the size of the pupils. The height of chairs and tables is important. Cutting tables should be 31 to 34 inches high; sewing tables from 27 to 29 inches, and chairs from 14 to 17 inches in height are desirable. Chairs of the same height may be used if footrests are provided, but it is better to have tables and chairs proportionate. A good general rule for the height of the table is that it should be slightly lower than the elbows of the workers. A rule for the height of chairs is that they should allow a position with the feet firmly resting on the floor and the knees slightly higher than the hips. One machine for four pupils is necessary in classes which use machine-sewing in making garments. For plain sewing, such as making shirt waists, house dresses, and the like, one machine to three pupils is desirable. The number of machines per class may be less than one to three or four persons only in courses which include a great deal of hand work.

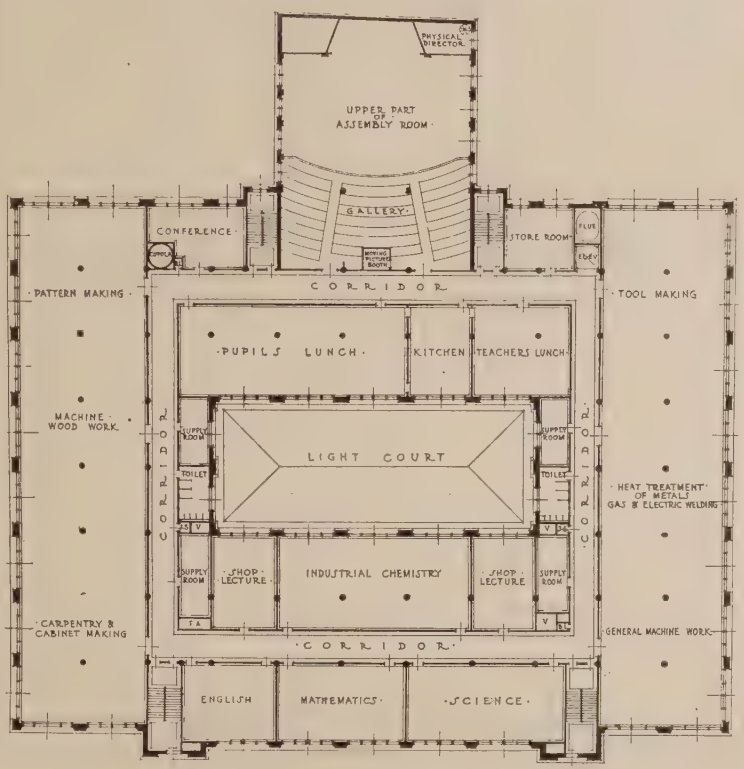
Large equipment, such as machines and workroom furnishings, as well as tools or utensils for general use, should be supplied by the school. Personal "tools," such as shears, pliers, thimbles, etc., may be provided by the school and the pupil encouraged to purchase the same.

Trade extension courses cannot be satisfactorily carried on in schoolrooms equipped with regulation desks and chairs. Such rooms are not adapted to manual work and the furniture is too cramped for adult pupils. Equipment for trade extension courses should be the same as in business establishments.

This brief statement relative to a few of these schools sets forth experiences which may be considered characteristic of others.

The Manhattan Trade School. — The Manhattan Trade School was established in November, 1902, as the result of a study made by a group of people interested in the sociological, economic, and educational status of the young working girl in New York City. Private initiative is responsible for the founding of the school, and voluntary contributions for the maintenance during the experimental stage.

The building selected for the school was a large private house at 233 West 14th street, which was equipped like a factory, and could comfortably accommodate one hundred pupils. In June, 1906, the school moved into a new business building at 209–213 East 23d street, which could offer daily instruction to about five hundred girls. The location was chosen because of its accessibility to the business district and to transportation facilities. The institution was taken over by the

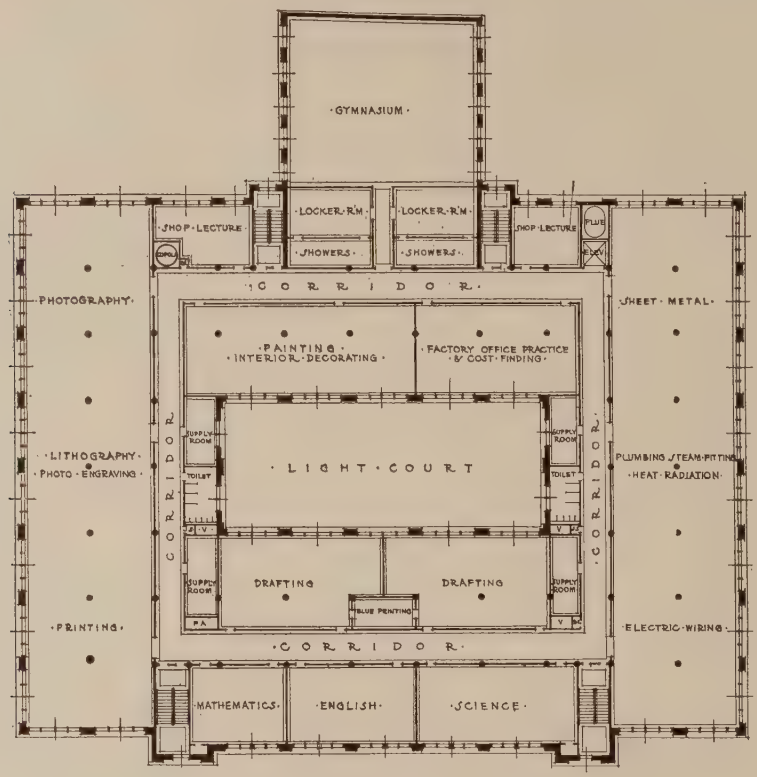


FIRST FLOOR PLAN

Fig. 167. — Vocational School, Newark, New Jersey.

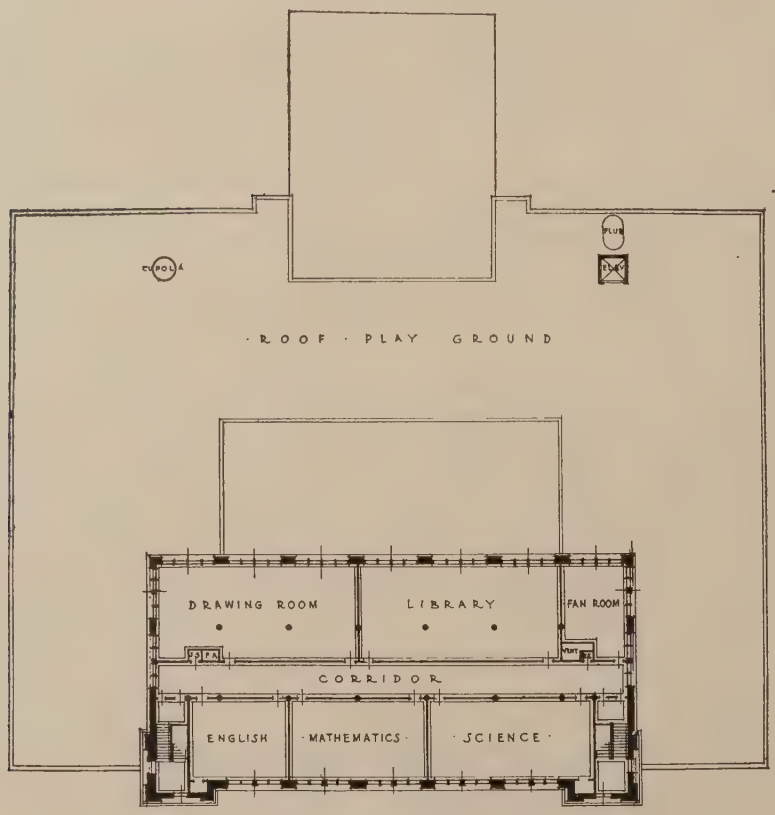
public school system September 1, 1910, and maintained in these quarters until September, 1918. The new building at Twenty-second and Lexington Avenue, a few blocks from the site of the old building, was opened on September 9, 1918, by the Department of Education. The building will accommodate 1200 girls; 600 are enrolled at present.

The first floor contains a spacious salesroom with attractive show windows on Twenty-second street and on Lexington Avenue, a restaurant capable of accommodating about seventy-five, and a well-equipped kitchen. The principal's office, the various other offices, and a lecture hall are on the second floor. The third floor



SECOND FLOOR PLAN

FIG. 168. — VOCATIONAL SCHOOL, NEWARK, NEW JERSEY.



THIRD FLOOR PLAN

FIG. 169. — VOCATIONAL SCHOOL, NEWARK, NEW JERSEY.

s divided into three large light sewing rooms, a large stock room, and plenty of wardrobe space. The fourth floor is similar to the third. On the fifth floor are four academic rooms and two other rooms, one of which will probably be given over to the millinery classes. The sixth floor contains rooms which it is likely will be devoted to the novelty work, art, manicuring, and hairdressing. The dressmaking and fitting rooms are on the seventh floor, and a spacious power-machine operating room and a cutting room occupy the eighth floor. On the ninth floor is a large lunch room for the girls and a kitchen where they will undoubtedly learn to cook. The tenth floor contains the gymnasium, lockers, and shower baths. The roof also is unusually attractive and is to be equipped for outdoor athletics.

Certain trades, or combination of trades, to insure all-the-year-round employment, are taught. Among those taught now, as major subjects, always carrying with them the related subjects, are dressmaking, millinery, lamp-shade making, electric power machine operating on clothing, embroidery, and straw; pasting trades, including sample mounting, novelty case making, French edge making, embroidery design and perforating of embroidery patterns, laundry work, cafeteria work, manicuring, and shampooing. The last two have been added this year to enable the girls to care for themselves properly. In all work special emphasis is laid on the necessity for the trade worker to keep in good physical condition.

By the sale of the products, though not an end in itself, the pupils are brought in touch with the real trade problems. No order is taken unless it serves the educational needs of the class. While an important feature from the standpoint of economy in cost, its educational value is paramount. Of the $20,000 received from goods in the year 1918, $16,000 was paid for supplies.

Milwaukee Public School of Trades for Girls. — In July, 1909, the Milwaukee Board of School Directors authorized the establishment of a school of Trades for Girls. The State Normal School building, vacated during the summer of 1909, was chosen for the location of the new school which was opened on December 6. To the original building a new addition has been added to accommodate the large number of applicants, the waiting list running as high as 200 names at a time. Four hundred girls are provided for in the building at the present time.

The school is located on Wells Street and occupies the southern half of the block between Eighteenth and Nineteenth streets. Transportation lines are accessible and close connections may be made with all car lines which run in close proximity to the school.

The school year is eleven months in length. Each weekly schedule consists of thirty-five hours. School hours are from 8.30 to 12.00 and from 1.00 to 4.30 daily except Saturday. Approximately two-fifths of the student's time during her course is devoted to work supplemental to her chosen trade and vitally essential to the skilled worker. The remaining three-fifths is spent in actual shop practice. One-half of the time spent in the shop must be devoted to trade work for the school and one-half may be devoted to the girl's own needs.

Students must supply their own drawing instruments and all drawing material, and the small tools needed in their respective trades, such as scissors, tape line, needles, emery, etc.

The various kinds of dressmaking trades, millinery, applied art and design have been selected to offer for instruction. Those desiring instruction in other trades are requested to make application. On receipt of a sufficient number of requests to make it evident that the demand warrants the expense of equipment, the school will consider the establishment of courses in the trades desired. Household science is taught as a course supplemental to the trades.

The Worcester Massachusetts Girls' Trade School. — The Worcester Girls' Trade School was established September, 1911, under the state and city ordinance providing for Independent Industrial Schools under the management and control of a Board of Trustees.

The school is located on State Street at the corner of Court Hill. It may be reached from every section of the city direct or by transfer. A remodeled dwelling provides for office, salesroom, power-machine operating room, and lunch room on the first floor. The dressmaking shops are on the second and the art and design classes are on the third floor. A separate dwelling is maintained for the four-year home-making courses.

By the generosity of David Fanning of the Worcester Corset Company this school has received a gift of $100,000 in recognition of its work.

The school year is 42 weeks in length and maintains a summer session of six weeks. The day school is open from 8.30 to 12.00 A.M. and from 1.00 to 4.45 P.M. every day except Saturday. The evening school session is 24 weeks. Classes meet Monday and Wednesday or Tuesday and Thursday from 7.30 to 9.30 P.M. The courses consist of short units of millinery and sewing which leads to dressmaking. A four-year course in home-making is offered and two-year trade courses in dressmaking, millinery, power-machine operating, and cookery, together with allied and supplementary subjects. Every girl's program includes:

One trade	22 to 25	hours	per	week
Cooking	3	"	"	"
Art	3 to 4½	"	"	"
Academic subjects	3 to 4½	"	"	"
Gymnastics	1½	"	"	"

Jane Hayes Gates Institute. — The Jane Hayes Gates Institute is a Home Economics and Trade School for girls and women under the direction of the Kansas City Board of Education.

The house is particularly well suited for this purpose. Trade efficiency and good-home-making is the ideal of all instruction. The rooms to the right and left of the doorway on the first floor are used as dressmaking and millinery laboratories. Lockers, irons and ironing boards, tables and chairs have been installed. The dining-room and kitchen are used for the preparation and serving of the lunch. The kitchen is large enough for several student armchairs, so a demonstration can be given there. The second floor has two domestic science laboratories perfectly appointed in every way. Another room is given over to the Industrial Art classes, another for the academic work, another for a cloak room, and another a rest room, which serves also as a demonstration bedroom.

FIG. 170.

The courses are planned to suit the needs of different classes of students, among whom is the girl who has just finished the elementary school and wishes to prepare herself for a definite line of trade work. The girls have the choice of two two-year courses, millinery or dressmaking. These courses comprise fifteen hours' work in the laboratory, which is conducted as a shop, three hours English, three hours mathematics, two hours of physiology and sanitation and textiles, four hours of industrial art, one hour gymnasium, and three hours of cookery. The fifteen hours a week shopwork consists in making certain required articles of clothing which are chosen as representing the different problems which are encountered in the dressmaking and millinery fields. An effort is made to develop judgment and taste as well as technique. The art work shows the use of the fundamental principles of design in the designing of clothing and house furnishings. Line, spacing, and color are studied with a special reference to the personality of the individual for whom the garment is designed. Color harmonies are worked out in various kinds and textures of materials suitable for blouses, dresses, suits, draperies, and wall coverings. Plaids and striped materials suitable for the different types of figures are

FIG. 171.

studied. In sketching, the emphasis is placed on design rather than drawing.

The course in cookery is planned to teach the different methods of food preparation and the principles underlying them. Besides this, each student takes her turn in the lunch room, where she has charge of the purchasing, preparation, and serving of meals. The keeping of household accounts, division of income, making household budgets are taught. There is a school garden which gives the girls some experience in production of food materials as well as supplying school cookery classes.

The second group of students consists of girls to whom the regular high school course does not appeal. These girls are particularly interested in the home problems and select courses which deal with the scientific solution of these.

In addition to these two groups the school offers special courses in Commercial Art, which prepares women to enter employment in the advertisement department of our business houses, in millinery, dressmaking, cookery, and home management. The courses last named are based on the home problems that every woman faces sooner or later, and have been so popular that it has proven to the directors of the school that there is a tremendous need and desire of the women of the city to learn to do their part of the world's work efficiently.

III. Buildings and Equipment

Types of Schools. — Vocational agriculture instruction is now being given in three types of secondary schools: (1) Separate agricultural schools, including congressional district, county, and privately endowed agricultural schools; (2) consolidated rural schools; and (3) small city and town high schools.

The Vocational Education Act of 1917, which appropriates Federal funds for the promotion of agricultural instruction in schools of less than college grade, provides assistance for approved work in schools of all three types under public supervision and control.

The act does not permit the expenditure of Federal moneys for plant or equipment for the schools established or in part supported by the act, yet through the provision which requires approval by the Federal Board of standards for plant, equipment, and maintenance, the Federal and State Boards for Vocational Education are interested in these problems, and increased attention will undoubtedly be given to them by communities and persons interested in introducing, providing facilities for, or carrying on such instruction.

The act mentions and provides for part-time and evening as well as all-day vocational schools, but buildings which meet the needs of all-day agricultural instruction will usually be satisfactory for part-time and evening classes and will not be discussed separately here.

It is obvious that the character and extent of buildings and equipment needed for the most effective conduct of vocational agriculture instruction must differ with the type of school.

The main business of the separate agricultural school is to give vocational instruction in agriculture. In the consolidated rural school and in the small city or town high school, vocational instruction in agriculture exists as a single department of a general school.

Separate agricultural schools commonly serve much larger areas than do the consolidated rural and small city and town high schools. The majority of their pupils live away from home, while probably all of the agricultural pupils of the consolidated rural high school and the majority of the agricultural pupils of the small city or town high school live at home.

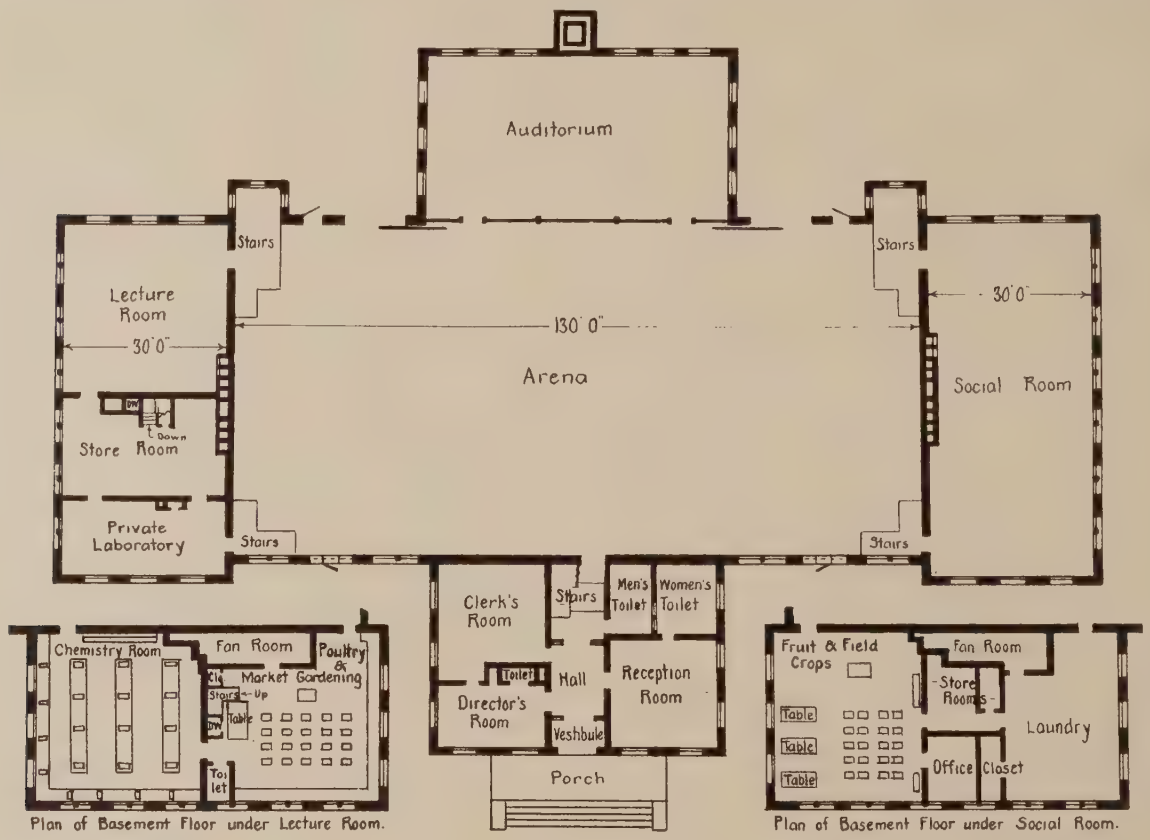
Separate agricultural schools ordinarily have a number of agricultural teachers and give numerous strictly agricultural courses. In the case of the consolidated rural and small town or city high school there is commonly but one agricultural teacher, and the number of agricultural courses given is necessarily limited by this fact.

Types of Buildings. — It is evident from the above facts that the separate agricultural school must have a more extensive equipment in land, buildings, laboratory and shop facilities and apparatus, and in general farm equipment than is needed for the consolidated rural or small city or town high school. As a matter of fact, most of these schools own farms of from twenty to several hundred acres and have from one to several buildings devoted entirely to agricultural instruction; where consolidated rural high schools serve a large number of school districts they sometimes have separate agricultural buildings and considerable land. But ordinarily they, like the small city or town high school in which agriculture is taught, have but little land and but one general school building, of which a part is devoted to agricultural instruction.

The number and kinds of buildings needed for the separate agricultural school vary according to conditions. Besides the main school building or buildings, various farm buildings will be needed, the number and sizes depending upon the size of the school farm, the kind of farming, and the course of study. Barns will be needed for work animals; sheds for stock, hog houses, poultry houses, etc., must be provided where animal husbandry is emphasized. Glass houses will be needed in truck and certain horticultural districts. Granaries,

cribs, etc. will be needed in grain districts. Provision for housing farm implements must be made wherever there is a school farm or exhibit collections of implements.

In the case of separate Congressional District Agricultural Schools and other similar schools serving a large area, some provision must be made for the housing and boarding of pupils who come from a distance. Where both boys and girls attend these schools, additional dormitory facilities must be provided. Even where the boys and girls do not live in dormitories belonging to the school the responsibility for their supervision rests upon the school. There is, therefore, a natural tendency toward general provision of dormitories for schools where the pupils cannot go home at night, as this decreases supervision difficulties besides presenting other obvious advantages.



FIRST FLOOR PLAN
SMITH AGRICULTURAL SCHOOL
NORTHAMPTON, MASS.

FIG. 172.

Smith Agricultural School. — One excellent type of school building for a separate agricultural school is shown in the plan of Smith Agricultural School, at Northampton, Mass. (figure 172). This type has been adopted with very satisfactory results in certain special and county agricultural schools in the East, and might well be more widely used for similar institutions. Its chief feature is the " arena " or inner court, within the walls of the school building. Doors large enough to drive in teams, stock, bring in pieces of machinery, etc., are provided. It is so arranged that it can conveniently be used for local fairs or exhibits, showing agricultural displays of farm crops, canned and preserved products, etc. It may also be used for community gatherings, demonstrations, lectures, etc. The social and agricultural teaching advantages of such an arrangement for a separate agricultural school in a rural community are apparent.

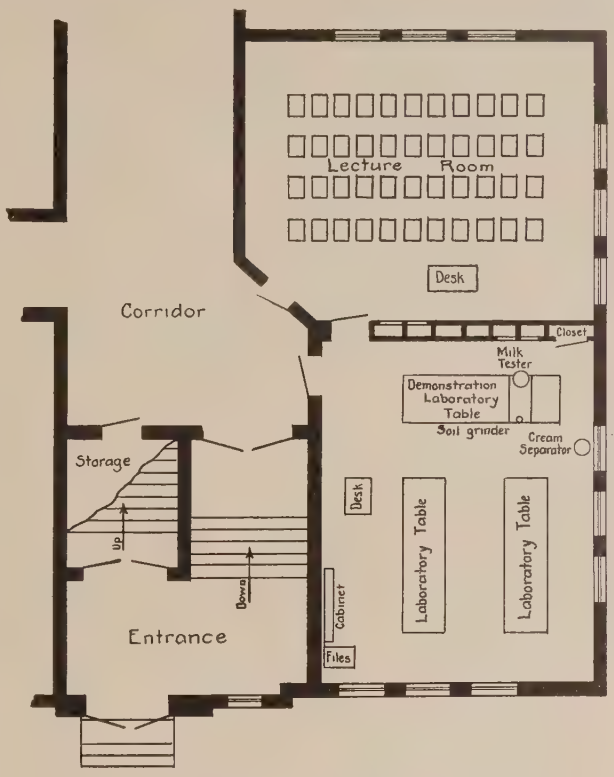
In addition to a main school building and the necessary farm buildings, the separate agricultural school frequently has from one to several other school buildings, as for example, a special farm mechanics building, a dairy building, etc. The number, nature, and size of these special buildings will be determined largely by the local and individual conditions of each school.

The general plan of such special buildings for use in vocational agriculture instruction will become more and more closely standardized as the conditions for most efficient instruction in dairy work, farm mechanics, and other special agricultural subjects instruction are worked out and agreed upon.

In the case of the consolidated rural high school and the small city or town high school, instruction in agriculture is ordinarily given in the same building with other high school instruction. In some cases grammar and elementary grades are even housed under this same roof. In the case of these schools, then, provision for vocational agriculture should consist in adding, besides the usual science laboratories, an agricultural laboratory and an agricultural recitation room. One satisfactory plan for such rooms is shown in figure 173, the agricultural laboratory of the Logan County High School at Sterling, Colorado.

Plan of Combination Laboratory and Recitation Room. — For the very small school a combination of laboratory and recitation room may be satisfactorily used. Where possible, it is an advantage to have the agricultural laboratory on the ground floor, so that the students may easily pass in and out at any time without disturbing other classes, and that illustrative material may readily be brought to and taken from the laboratory.

If farm mechanics instruction is given, it is desirable, when possible, that it be given in a separate building, whatever the type of school. If it is given in the same building with other school instruction, it is difficult to prevent the noise necessarily incident to the work from disturbing the other school work. Ideally, there should probably be a separate room for the carpentry, for the blacksmithing, and for the toggery. But though this can often be provided for in Congressional District and County High Schools, the other classes of schools will usually have to be content with more modest quarters.



AGRICULTURAL LABORATORY
THE LOGAN COUNTY INDUSTRIAL ARTS HIGH SCHOOL
STERLING, COLORADO.

FIG. 173.

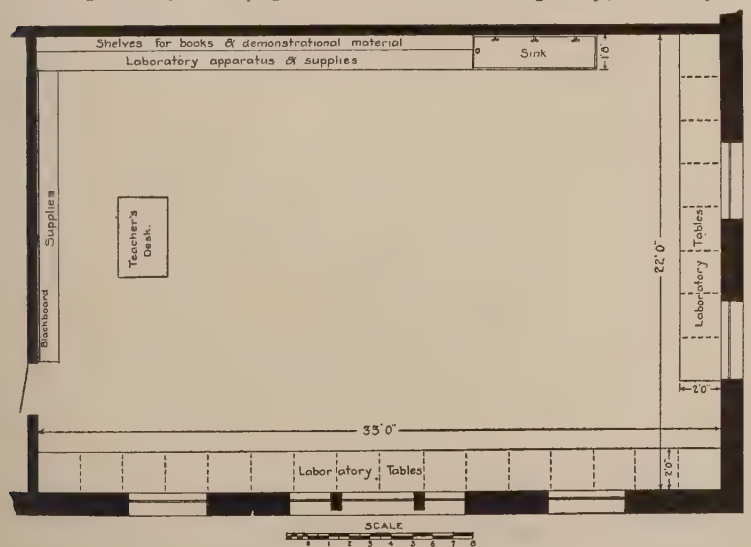
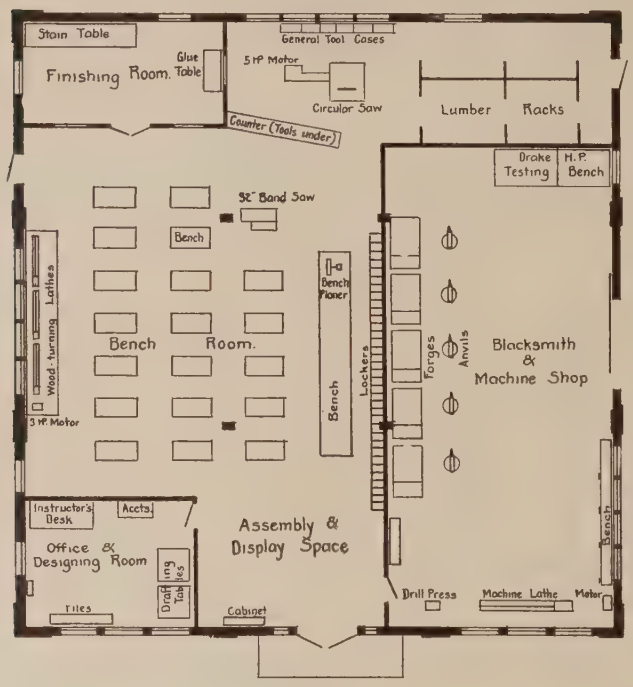


FIG. 174. — PLAN OF COMBINATION LABORATORY AND RECITATION ROOM, LOGAN COUNTY INDUSTRIAL ARTS HIGH SCHOOL.

Shop Building, Sterling, Colo. — One type of separate shop building is shown in figure 175, that of the Logan County High School at Sterling, Colorado.

A Combination Shop Suggested. — Where it is not possible to have a separate building for shopwork, a room in another building, possibly even in the basement of the school building proper, may have to suffice temporarily at least. New York bulletin 626 suggests the following shop room:

"Under average conditions the room for shopwork can be found. It should be at least 16 by 24 feet in area, well lighted, and preferably with a south exposure. Rooms not already suitable for the purpose may often be made so at small expense. If absolutely necessary, a basement room may be fitted up. In this case additional windows will frequently be needed. Under the row of windows there should be a continuous bench, preferably



SHOP

THE LOGAN COUNTY INDUSTRIAL ARTS HIGH SCHOOL
STERLING, COLORADO.

FIG. 175.

built of two-inch planks. This bench ought to be 24 to 30 inches wide. It should be provided with wood vises, at intervals of 5 feet.

"At the end of the bench nearest the forge and anvil there should be one blacksmith's iron or machinist's swivel vise. A good grindstone, mounted by the pupils, can be placed conveniently, and vertical cabinets for the tools belonging to the school can be built by the first class from their own designs. Some open space should be reserved in the middle of the room for the use of sawhorses, for setting up work in course of construction, and for testing the operation of machinists. The forge should be so placed as to exhaust the smoke and gases into the regular furnace stack when possible.

"The ceiling of the room should be properly prepared to deaden the sound of work done in the shop. The under side of floor joists overhead should be sheathed with 'deadening felt,' and this covered by a tight wooden ceiling or by lathing and plastering. Metallic ceiling should not be used, because of its sound-conducting properties.

"The floor should be of wood except around the forge and anvil. Cement floors are cold and hard on the pupil's feet. An edged tool may be spoiled by dropping on a cement floor. If cement foundation is used, the corner designed for the forge may be left uncovered when the wood floor is laid. If the room to be used as a shop already has a wood floor, a covering of zinc, tin or galvanized iron should be placed in the corner where the forge and anvil are to stand."

Figure 176 shows a combination shop which may be made to give satisfactory service in a small school.

Since the majority of the agricultural pupils of the consolidated rural high school and the small town high school live at home and can carry on supervised practical work there, such schools will ordinarily own but little land for agricultural uses. They will therefore need but few farm buildings, farm implements, etc., compared with the separate agricultural schools. Primary factors in determining what these shall be will be the amount of land owned or leased for agricultural purposes, and the character of the crops grown.

As has been indicated, agricultural schools will have a series of agricultural laboratories and recitation rooms,—as for example a farm crops laboratory, a horticulture laboratory, etc. In the smaller schools where vocational agriculture is taught, there may be but one agricultural laboratory, used for different classes. In this case it must be fitted up to meet the various needs.

There must be laboratory tables suitable for the kinds of work undertaken, with gas, sinks, running water, etc. Where there must be a single combination recitation and laboratory room, flat-topped tables and chairs with suitable cases for apparatus and supplies must be provided. There should be cabinet cases for demonstration material, grains, seeds, feeds, fertilizers, etc.

Unless the school has ample space in its library room or rooms for the shelving and care of agricultural books, bulletins, and magazines, provision must be made for them in the agricultural laboratory, or recitation room. There should be abundant storage room for illustrative collections, extra pieces of apparatus and supplies. There must be suitable provision for the storage and for the display of soil service maps, charts, pictures

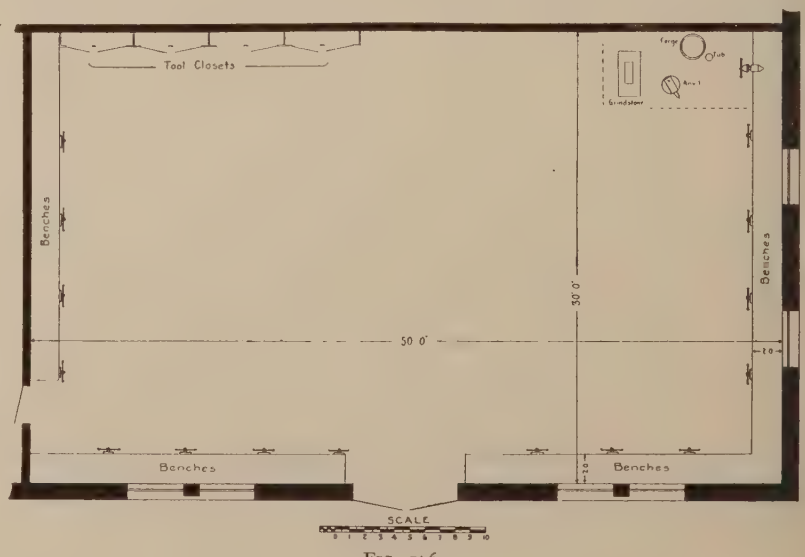
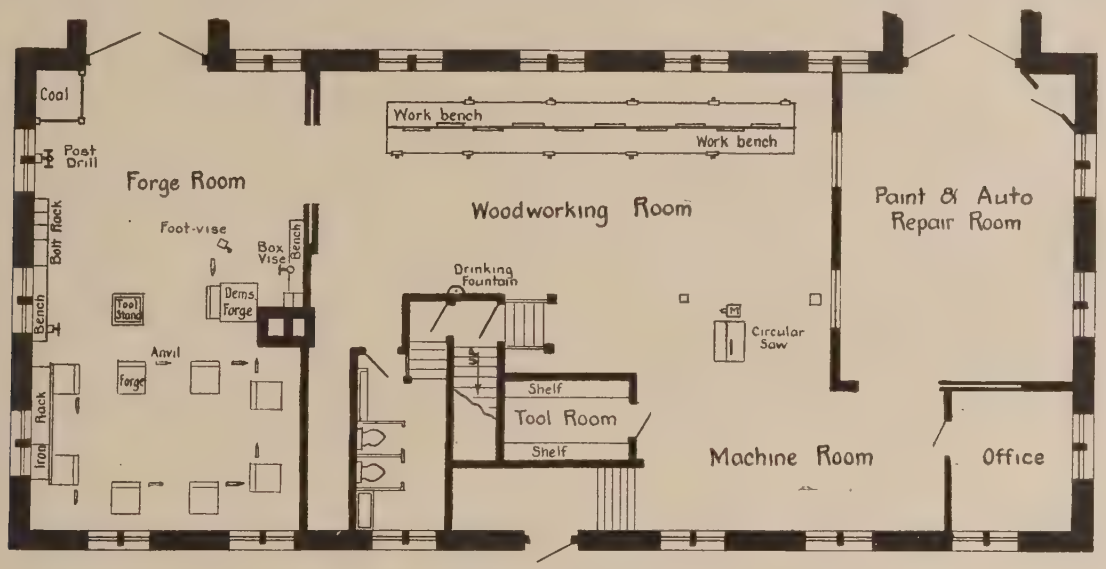


FIG. 176.

of live stock of the various kinds, and other illustrative material.

Discussion of the special apparatus and equipment desirable for use in connection with the different agricultural courses involves so many considerations that it cannot be adequately treated in a few pages. It will therefore not be touched upon here.



BASEMENT PLAN

NEW SHOP BUILDING FOR SMITH AGRICULTURAL SCHOOL.
NORTHAMPTON, MASS.

FIG. 177.

IV. HOME ECONOMICS

Purpose of Vocational Home Economics Schools.[1] — Home economics as a vocational subject has for its controlling purpose the preparation of girls and women for useful employment as home-makers and as house daughters engaged in the occupations and management of the home, preparation for useful employment in an occupation which is a composite of undifferentiated occupations requiring various forms of skill and of related knowledge. Such employment may or may not be wage earning employment. It is wage earning employment for household assistants. It is not wage earning employment in the general acceptance of the term for home-makers who are at the same time workers and managers in their respective enterprises. As such they have need for forms of vocational education especially adapted to meet their needs both as workers and as managers.

Home-making Activities. — Home-making is both a social and a business enterprise. Under ordinary circumstances the efficient home-maker must be a responsible, skilled worker in at least four or five skilled occupations; under emergency conditions this number may be greatly increased. In addition, she is usually joint owner and manager of the whole enterprise, and she must be skilled in household management.

Schools offering vocational instruction in home economics should provide for three types of workrooms.

First, adequate space and equipment for instruction and laboratory practice in all of the home activities, such as housekeeping, garment making, dressmaking, food study and cookery, serving of meals, laundry, home nursing, and the care of children.

Second, adequate space and equipment for instruction and laboratory practice in the related sciences and art which are fundamental to a proper understanding and application of home-making processes. These will include such subjects as general science, applied physiology and home nursing, household chemistry, household physics and applied drawing and design, costume design, house furnishing and decorating.

Third, there should be adequate space and equipment for the non-vocational or general academic subjects.

Schools Teaching Home Economics. — Vocational home-making is offered in three kinds of schools, namely, *day schools*, *part-time schools*, and *evening schools*. The type of instruction does not vary materially in these three kinds of schools, and the plant and equipment which is best designed for efficient work in the day

[1] Prepared by Miss Anna E. Richardson, Acting Assistant Director for Home Economics, Federal Board for Vocational Education.

schools will serve for work in part-time and evening schools. For the purpose of this article only the day school will be discussed.

Types of All-Day Schools. — All-day schools are of two types, separate home-making schools which provide equipment and space for the entire vocational and non-vocational curriculum, and home-making departments of trade schools, general elementary, and high schools where space and equipment is provided for the home economics subjects but where the classrooms of the general school are used for the work in applied science and art and the non-vocational subjects.

Separate Schools of Home-making have been housed in whatever type of building was available. The types of building in common use are old school buildings and remodeled homes. The Newark Girls' Vocational School is a fair representative of the first type, and the Essex County School at Bloomfield, New Jersey, is a representative of the use of the second type of building.

For the separate school the remodeled house is more desirable if the vocational class is not too large. It provides the opportunity for work under approximately home conditions, as the house may be furnished as a home and all of the home-making activities provided for. Unfortunately most of the homes so used are very large, old-fashioned houses with the inconvenience of large rooms, waste spaces, and poorly planned working areas.

Home-making Departments of Trade Schools. — The home-making departments of the trade school, as for example the Worcester Trade School, Worcester, Massachusetts, and the Jane Hayes Gates School, Kansas City, Missouri (see figures 170 and 171, page 194) offer the opportunity for equipment which approximates trade equipment. Some of these departments are fitted up with laboratory kitchens and sewing-rooms, but more often the sewing-rooms are equipped for shopwork and the food preparation is a part of the lunch room work. The equipment for technical home economics is good, but in such departments the equipment for related art and science is apt to be inadequate.

Home-making Departments of Elementary or Secondary Schools. — When home-making is a department of the general public schools, we usually find the laboratory type of equipment, the extent of space and equipment depending upon the school. In the best schools the kitchen laboratory is fitted with individual work-tables to accommodate 15 to 20 students. A dining-room is furnished for the serving of meals and adequate storage and pantry space is provided. The sewing-room is fitted with tables and chairs of the right height for comfort in sewing and cutting. In many of the schools, housekeeping apartments are provided in addition, which are used for class instruction in home management, home nursing, and house furnishing and decorating. The school science laboratories are used for the related science instruction, and the regular classrooms for the non-vocational work. This type of equipment is common to home economics departments throughout the country, and is discussed at length in another section of this book. Unmodified, the straight laboratory equipment is apt to be too formal, too remote from the home activities of the girl and is one of the reasons why much of the home economics as given does not produce independent home workers.

Modifications of Equipment. — The recognition of the fact that, if instruction in vocational home-making is to be effective, it must be carried on under as nearly normal conditions as possible, coupled with the fact that most of this training must be given in the schools, as it is impossible to provide home-making training for each girl in her own home, has led to various modifications of the school equipment.

The usual floor space devoted to Home Economics does not permit the instruction to partake of the activities of the home to a sufficient degree. In the beginning, equipments were installed in vacated classrooms or in unused basement space and were limited to small composite tables containing the stove and equipment, for the use of the pupils.

In a High School. — With the advent of vocational home economics it has been found necessary to increase to a considerable degree the floor space available. The plan suggested in figure 178 is intended to be incorporated in the general plan for a cosmopolitan high school as a department for vocational home economics. The architect will find it necessary to apply this suggestion to local conditions. It may not be possible to allot to this department the floor area shown. On the other hand, in some buildings additional space may be available.

In this plan the entire space covering 4400 square feet is divided by partitions about nine feet high, into sewing-room, fitting room, four unit kitchens, rest room, laundry, storerooms, and an apartment, made up of dining-room, kitchen, bedroom, and bath. The sewing-room is amply provided with sewing tables 2′ 8″ high, comfortable chairs, hinged ironing boards and adequate locker space, and has adjoining storage and fitting rooms.

The apartment may be used for various home management problems, service of meals, care of the house, home nursing, and house planning, furnishing, and decorating. The kitchen of the apartment is fitted up as a convenient home kitchen and the arrangement is planned to save time and energy in manipulative processes. This kitchen, with the other units, is used for

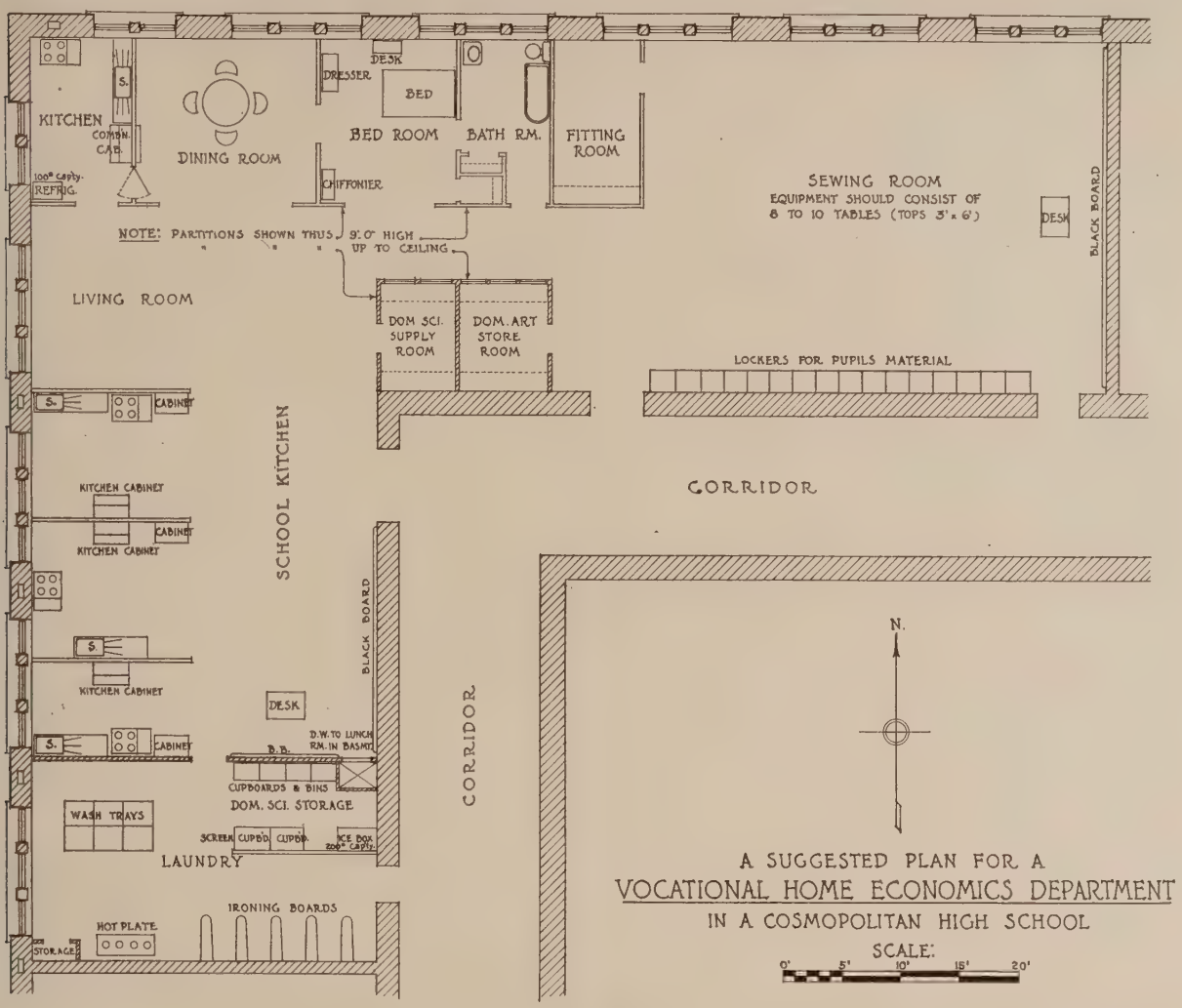


FIG. 178.

class work, three to five students in a kitchen, depending upon the number of students in the class. The kitchens differ slightly in size and equipment, so as to allow for some experimentation as to the most effective arrangement. Ample space is allowed outside of the units for chairs and a blackboard where the class may be assembled, without loss of time, for explanations, discussions, and instruction. This is a very important feature, often neglected in schools with unit kitchen equipment. The open alcove adjoining the apartment kitchen may be fitted up as a rest room or a sitting room. This provides for a place to read or work and gives further opportunity for working out problems in decorating, furnishing, and care.

It has been found that a class of from ten to twenty pupils composes a working group under one instructor. The plan as suggested will ordinarily provide instruction for as many as sixty pupils under the direction of three teachers.

As a means of greater flexibility, the rooms should be designed with all interior dividing partitions of light construction and extending only nine feet above the floor, with open ceilings. The partitions should be constructed so that the walls may be decorated in keeping with similar rooms in the home. The interior partitions between the "unit rooms" and the open space have in most cases been omitted in order that the instructor may have an opportunity to supervise the work of the pupils more readily.

Essential Points. Light. — All "unit rooms" and floor space for general instruction should be well lighted by natural light. The rooms should be wired for the usual artificial light as specified elsewhere in this chapter. In addition, extra service outlets should be extended to the equipment in each of the unit rooms.

Floors. — All floors should be of wood, or, if of concrete, covered with battleship linoleum.

Interior Partitions should be constructed of light

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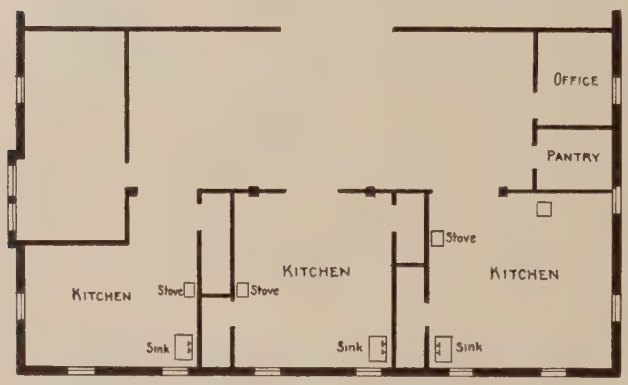
frame work covered either with plaster or compo board, so that the walls may be decorated similarly to the home. Doors should be hung on the openings in the bedroom, bathroom, fitting room, storage rooms, and laundry. In the partition separating the dining-room and kitchen a combination buffet and kitchen cabinet should be constructed. This should be flush with the wall on the dining-room side, above the counter shelf, and fitting with a sliding door permitting the passage of articles from the kitchen to the dining-room.

Ceilings. — The usual height ceiling, from 11 to 13 feet, is satisfactory.

Heating and Ventilation should correspond to the usual requirements for school buildings.

Supply Rooms. — In the supply rooms, adequate shelving should be placed for the storage of a considerable quantity of material. For the storage of dresses,



Floor Plans of Unit Kitchens

FIG. 179.

large built-in cabinets with sliding doors in which dresses can hang at full length, should be provided. Individual pupil's lockers should also be constructed in the sewing room as indicated. These should be equipped with individual locks, fitted with a master key.

Equipment. — The plan should show the installation of all equipment, so that service and plumbing outlets may be extended to the fixtures. The equipment should be similar to that used in the average home, and should be selected of the best makes so as to stand considerable usage. A four-hole gas range with baking and broiling ovens should be placed in each kitchen. The kitchen sink, whenever possible, should be fitted with a double drain board. While a porcelain drain board is more desirable for sanitary reasons, experience shows that a wooden drain board is more serviceable. All kitchen sinks, drain boards, etc., should be installed so that the working surface is from 36 to 38 inches above the floor. Each kitchen should include a kitchen cabinet, preferably a built-in combination work table with shelves and a storage space below.

The laundry equipment should include two batteries of three tubs each for washing purposes. These should be connected to hot and cold water with the hot-water heater in the room. A family electric washing machine and a 42-inch electrically operated mangle and electric irons should be included in the equipment. The electric wiring should provide convenient service outlets for this equipment. At least five ironing-boards should be provided. These should be so attached to the wall that they may be raised to an upright position when not in use. A clothes dryer connected to steam coils is an essential part of the equipment. Simple home equipments should also be used and comparison made as to their relative efficiency.

A much simpler plan for the unit kitchen is illustrated in figure 179. This shows the main laboratory space divided by partitions into three average size kitchens equipped as home kitchens. It is recognized by every one that the most valuable experience is obtained when the pupils are engaged in production under the same conditions that exist in the factory, the home, or on the farm.

For the sake of economy and the stimulus that comes from the preparation of a product which is to be used, some method must be devised for using the dishes prepared in the school kitchen. Most modern schools include a lunch room, and the product of the home economics department may be used there.

Since most lunch rooms are located on the first floor, and as a rule the home economics department on the second or third floor of the building, a dumb-waiter connecting the two is a necessary addition to the equipment.

The practice house is an extension of the plan to provide home equipment in the school for instruction in home economics. In most cases the girls do not live in the house, but the usual home-making activities are carried on, including preparation of the noon meal, laundry, house cleaning, etc. This, in combination with the school equipment, provides for each girl an opportunity to do independently the work of the home for a definite period of several weeks or more.

Cafeterias and lunch rooms are other means of furnishing vocational experience under normal conditions. Such experience is of great value when the preparation of the lunch is made an educational project. Most careful planning is necessary, however, to see that the positions are changed frequently enough, so that the work does not degenerate into routing practical work.

Standards in the Selection and Equipment of Rooms for Home Economics Instruction. — In utilizing an old building or in planning a new one, there are certain fundamental standards which are of importance in

choosing and equipping rooms for home-making instruction, which should be taken into account by the architect. These deal with location, size, shape, lighting, ventilation, floor materials, and wall finishes.

Location. — The school kitchen should be a corner room; the cross drafts eliminate odors and provide ventilation. The corner should be chosen which shade, prevailing winds, or other local conditions make coolest. The first floor is to be preferred, as it is more accessible for supplies and the removal of waste. This should not be a basement room, as a basement room seldom provides adequate light, ventilation or other opportunities for healthful work. The top floor of the building prevents odors from spreading through the building, and is satisfactory if the building is not more than three stories, or if there is good storage space so that supplies may be purchased in large quantities, and adequate elevator service is available.

Good light is an essential for the rooms where sewing is taught; therefore a north exposure should be used if possible since it provides the best light. The location of the rooms for the other home-making activities is not so important. The rooms should, however, be planned in relation to each other so that the work done can be accomplished at the least expenditure of time and effort.

Size. — The size of the rooms will be determined by the number of pupils to be taught and the use of the room, whether or not it is to be used for only one home-making activity or for a combination work room. Twenty students should be the maximum number taught in a vocational class, and fewer are desirable. The working area per pupil in either food or clothing classes should be about 30 square feet distributed in a rectangular space of about 30 feet by 25 feet. There should be aisle space of not less than three feet in width and ample storage space for all equipment.

A square or slightly rectangular room is best fitted for a kitchen, dining room, or pantry. For a sewing-room a narrow room is best, as it allows the light to come from one side and fall all the way across the room.

Lighting. — The rooms should be well lighted, the glass area should be not less than one-fourth the floor area. Good artificial lighting should be provided, conforming to the usual standards for artificial lighting, that is, it should be adequate, suitably placed and easily available. For sewing the same standards as for cooking should prevail with more allowance for the adjustability of artificial lights and in general with more emphasis placed on light.

Ventilation should be as nearly as possible perfect, to insure both the health and comfort of the students. If a ventilating system is not in use in the building, ventilation must be secured by windows opening at both top and bottom, and the school kitchen should have windows on two sides of the room.

Wall finishes will be determined by the location and use of the room. In general they should be light-colored and easily cleaned.

All plans for home economics departments should be submitted by the architect to a well-qualified home economics teacher. This will insure the equipment being adapted to the needs of the school.

CHAPTER IX

THE HYGIENE OF SCHOOLS

By Robert T. Legge, M.D., *Professor of Hygiene and University Physician in the University of California, Berkeley, California; Fellow of American College of Surgeons; Captain, Medical Corps, U. S. Army.*

Ventilation. Odors. Temperature. Humidity. Air Currents. Bacteria. Dust. Heating. Lighting. Desks. Plumbing. Open Air Schools. Health and Safety Welfare.

The Hygiene of Schools

A volume of this sort, prepared by specialists, each of whom deals with problems from his own standpoint, be it æsthetic, economic, or some other, would be incomplete without a chapter on school hygiene. The subject is obviously very important, for it deals with the health of the occupants of schoolrooms and buildings. Scientific knowledge gathered from research and clinical observations in many places is available, and it must be applied to modern schoolhouses, in order that these shall conform to certain requirements and standards. Many studies of the situation have been made in various states by educational and public health officials, and it is the general opinion of such observers that one-half of the schoolhouses in this country should be destroyed on account of their unsanitary character. Despite such opinion school authorities and trustees continue to erect highly unsuitable school buildings without consulting specialists whose services in the premises are indispensable for the safeguarding of public health. Of the many problems that are to be considered, those of health and safety are first in importance; second are those of convenience and the promotion of comfort. Attention to these makes the pupils' and teachers' workshop liveable and makes possible the elimination of much lost motion, and at the same time conduces to happiness and intellectual development.

It is the purpose of the writer to present the important hygienic factors necessary in the modern scientifically constructed schoolhouses.

Ventilation. — Ventilation may be defined as the changing or removal of confined air, charged with chemical or physical impurities, by normal outside air. To discuss this very important subject from a hygienic standpoint, we must be familiar with the chemical and physical properties of air, the physiology of respiration and circulation, as well as the effect of ventilation upon the cutaneous and nervous systems. It required two commissions on ventilation in this country to solve this problem, and their labors have not yet been completed.[1] Normal or pure air, which is more characteristic of rural than of urban districts, is composed of a mixture of gases, consisting by volume approximately of 20.65 parts of oxygen, 77.11 parts of nitrogen, 0.79 part argon, 0.03 part of carbon dioxide, and 1.4 parts of aqueous vapor. There are traces of other gases which are, however, for our purposes, of slight importance. Changes in the composition of air are produced by the presence of human beings when confined within close quarters, as each person so confined exhales at each breath 4.4 per cent of carbon dioxide, thereby increasing the amount of this gas and diminishing the relative amount of oxygen present. At the same time moisture and heat are eliminated from the lungs and skin, thereby increasing respectively the humidity and the temperature. In this manner odors and bacteria are exhaled into the air, the combination producing the so-called "crowd air." Changes in air, due to combustion, are produced by heating and illuminating devices, such as the different sorts of gas and oil lamps and stoves.

Old ideas of ventilation were based principally on the carbon dioxide content of the air, and were proposed by Pettenkoffer. Some of our text books to-day continue to publish methods of testing for the amount of carbon dioxide present and give as the upper limit .06 per cent as the standard for good health, and an increase over that of from four to ten per cent as the beginning of the danger point.[1] At each expiration the amount of oxygen exhaled is about 16 per cent of the expired air, the difference between the 21 per cent of normal air and the 16 per cent mentioned having been taken up by the hæmo-

[1] See Reports of New York Commission on Ventilation, American Journal Public Health, February, 1914.

globin of the blood. Yet vitiation due to an increase of CO_2 and the decrease of oxygen has been proved of minor importance.[1]

Odors. — Odors which emanate from persons are the result of organic matter passed off in vapor from the lungs, mouth, skin, and cavities of the body. These odors, prevalent in " crowd air," are unpleasant and at times nauseating but, according to Winslow, have never proved injurious.[1] They bear about the same relation to health, as far as danger is concerned, as sewer gases which were once believed to be so menacing.

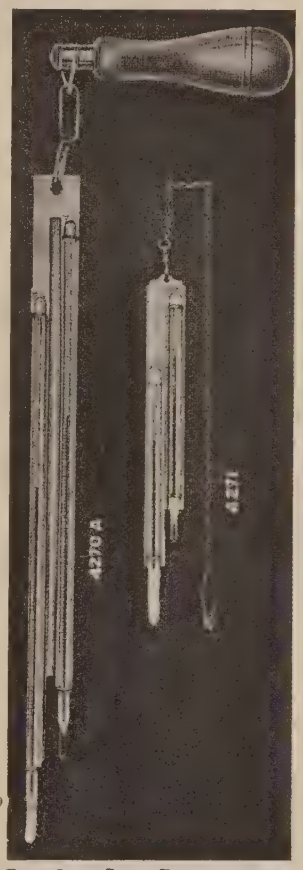


Fig. 180. — Sling Psychrometer.

Temperature. — Temperature varies according to climate, altitude, seasons, etc., but the body heat remains about the same, 98.4 degrees Fahrenheit. People adjust their diet, clothing, housing and exercise to these conditions. The temperature of a room should not exceed 70 degrees Fahrenheit, preferably 68 degrees. When a confined space is overheated it produces vaso-motor disturbances in the peripheral circulation of the skin of the occupant, which gives relief to the body heat radiation. As Haldane [2] and Winslow [1] state, too high a temperature is injurious to health if maintained, as it lowers efficiency, causes fatigue, lassitude, and anæmia, decreases metabolism, and produces a predisposition to acute and chronic diseases. These conditions are intensified when a high relative humidity is also present. Every schoolroom should have an accurate thermometer suspended about two and one-half feet from the floor in the middle of the room, and not near a heating device. The use of a thermostat for regulating heating appliances is ideal for maintaining a uniform artificial heat to comply with the above standards.

Humidity. — Humidity is a great factor in the question of confined air and the subject of ventilation. An excess humidity exerts the same influence upon the vaso-motor cutaneous system as excessive temperature. We are familiar with the experience of depressing hot days when the atmosphere is filled with moisture and our clothing feels " sticky." This condition illustrates how the internal heat, in its attempt to radiate from the body, brings into play the activity of the sweat glands of the skin, producing perspiration which, under ordinary circumstances, evaporates and reduces the body temperature. When the temperature of the atmosphere is raised, the amount of moisture contained in it increases and it may become saturated. In overheated rooms, when the air is excessively dry, we note how the moisture is extracted, particularly from our noses. Thus, in a short time, the mucous membranes become dry, and in the attempt to overcome this condition a congestion is experienced, which easily develops an infection and a cold in the head may be the result.

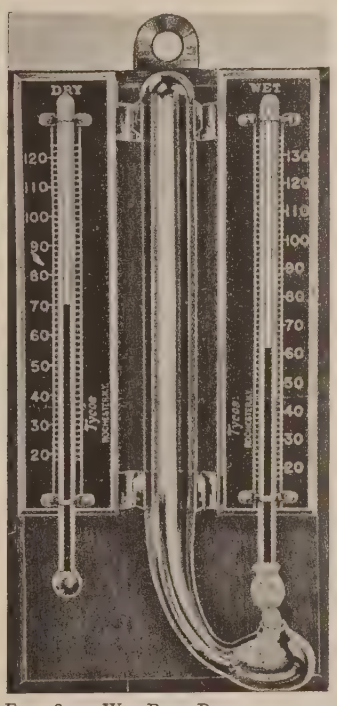


Fig. 181. — Wet Bulb Psychrometer.

The wet-bulb psychrometer is an instrument every school should possess for determining the temperature and relative humidity of the room. When the dry bulb thermometer is at 68 degrees, the wet bulb should register not more than 66 degrees. Authorities have stated that the minimum amount of humidity should be 35 per cent and that the desirable percentage of relative humidity should range between 40 and 60 per cent.

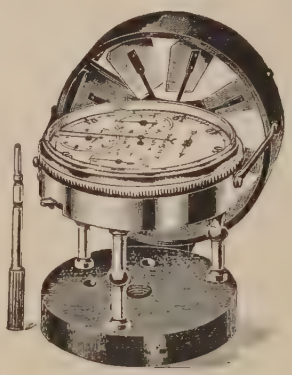
Increased temperature with a relatively high humidity is unhygienic. If maintained it causes depression and fatigue, decrease of resistance and metabolism, thereby predisposing its occupants to acute and chronic diseases. Moisture may be imparted to the air by exposing pans of water on radiators, or by a humidifier which exposes to the air, as it passes through the registers, a surface of cotton wicking communicating with the reservoir of water.

[1] See E. A. Winslow: *Scientific Basis for Ventilation Standards.*

[2] Haldane, Second Report of Departmental Committee on Humidity and Ventilation in Cotton Weaving Sheds.

Air Currents. — These are undoubtedly of the greatest importance in the matter of ventilation, as they keep the air in motion, thereby preventing its stagnation about our bodies. They play an important rôle in the peripheral circulation of the skin by causing evaporation of the moisture from its surface. Every one has experienced how refreshing it feels to leave a close or warm room for a breath of outdoor fresh air. It awakens our intellects by relieving and regulating the heat mechanism of our bodies by producing radiation and evaporation from the skin. In a room overheated by steam radiators, the air soon becomes scorched and is usually stagnant.

When air currents are colder than the air that surrounds our body we experience a draft which is not felt in the open. In the mechanical or natural methods of ventilation the air movement when delivered three and one-half feet a second produces a draft. As the surface vessels contract, the blood is sent internally and radiation is reduced to a minimum. That drafts cause " colds " is a worn-out theory, although with persons who coddle themselves and live sedentary lives indoors, a draft may impinge upon a small area of the body and produce an effect upon the vascular system which, being unable to adjust itself, reacts and produces a congestion, as for example in the nose or muscles. School children should be well exercised, taught the value of cold baths, fresh air, less clothing than usual and proper food. Under such conditions the vasomotor system will react automatically and the danger of drafts will be obviated. To sum up the question, as Professor Lees tersely expresses it, " It is not a chemical but a physical, and not a pulmonary but a cutaneous problem." People who are always "catching colds " from fresh air or drafts do not require more clothing, or warmer houses, but a doctor to determine whether an infected tonsil, bad teeth, or other local infection is not responsible for the trouble.



ANEMOMETER.
Fig. 182.

Bacteria. — Bacteria are found in larger numbers in ill- than in well-ventilated rooms, but the danger of infection from these is practically nil.[1] When persons are infected it usually results from coming into contact with the exhalations of a diseased person through coughing and sneezing. Moisture is disseminated in the air with disease germs. This is known as the " droplet " method of infection, and is by far the greatest factor in producing respiratory diseases, such as colds, measles, tonsillitis, etc., etc.

Noxious irritating gases and smoke play an important rôle in the question of ventilation in industrial hygiene, but the small amount of chalk and floor dust of a schoolroom hardly plays any rôle as a factor in ill health. Ready methods of detection which are always at hand to determine when a confined space is not properly ventilated are afforded by the presence of odors, yawning, headache, and even nausea. External ventilation is important and should always be considered when selecting a site for a school building. There should be large grounds, bordering on streets or parks, at a sufficient distance from tall buildings, smoke stacks, and factories.

To summarize, ventilation must comply with the following requirements:

1. An interchange of pure air from without to dilute the products of respiration and vitiation.
2. The maintenance of a proper temperature, of from 65 to 68 degrees Fahrenheit.
3. A supply of the proper percentage of humidity, which is considered to be between 50 and 65 per cent.
4. A gentle motion of the air is essential.
5. Freedom from dust, odors, bacteria, and gases.
6. Removal of the products of combustion.

The most satisfactory method for the ventilation of schoolrooms is by means of open windows. The ideal method is by cross ventilation, which affords motion and interchange of pure air. In some of our old text books we find reference made to the use of window boards, window pane ventilators, and other devices to retail the air. Such methods are entirely inadequate. If the air from without is too cold, artificial heat delivered from within should counterbalance this discomfort, a principle always observed in open air schools and hospitals. The thermometer and thermostat to regulate temperature, the psychrometer to determine the humidity, and the anemometer to measure the air currents should be familiar instruments in every school. Every teacher should be taught to understand their use properly, as well as the principles of heating and ventilation.

When mechanical heating and ventilating devices are installed, as explained in another chapter, the accepted standards must conform to certain requirements. It is universally conceded that an adult requires from 1800 to 2400 cubic feet of fresh air hourly. The minimum amount of air entering the room for each person should be not less than 30 cubic feet per minute. The air enters the vent which has deflectors pointing upward. These are located eight feet from the floor and

[1] Winslow and Klieger.

measure approximately two feet square, with a slightly larger outlet near the floor. Such an opening is sufficient to take care of the modern school room of forty pupils, permitting a velocity of air entering as measured by the anemometer of from 350 to 400 feet every minute. The ducts to each room of forty pupils should be at least four square feet in cross section, so as to keep the velocity within them down below 400 feet per minute. To determine air circulation an anemometer is moved over slowly the area of the vent, and is timed by a watch while the velocity of the air entering is read on the dial. The determination is finally made by multiplying the reading by the number of square feet in the opening for sixty seconds. This should equal the quantity entering and be then divided by the number of pupils, giving the amount for each person. For example, three hundred feet times four feet equals twelve hundred feet, divided by forty pupils equals thirty cubic feet per minute. High temperature, imperfect humidity, motionless air in rooms where the occupants are physically inactive are the factors which are responsible for vitiated atmosphere. This is a school problem of great importance and magnitude, for it is reasonable to presume that a child in such an atmosphere is dull and nervous and, in consequence, robbed of his power of concentration. Window ventilation is, after all, the easiest and best method of flushing a room with pure air, and is far superior to any mechanical heating or ventilating contrivance which supplies "canned air." The New York Health Department after careful investigation found that in classrooms with closed windows and ventilated with mechanical methods, children were more subject to respiratory diseases than were children in classrooms kept at the same or lower temperature and ventilated wholly by open windows.[1]

Dust. — Dust as a factor in aërial infections in schoolrooms is practically nil, as has been proven by experiments. Probably the only pathogenic organisms likely to be transmitted are pus cocci and tuberculosis. Most of the communicable diseases are transmitted, as already stated, by infected persons, carriers, and convalescents, whose exhalations from coughing and sneezing spray into a small zone about their bodies small droplets carrying disease organisms which, when inhaled by another, produce disease in him or her. It may be relied upon that this is the usual course of infection and by direct contact, as from a common drinking cup, and not from chalkdust or dirty floors.

In this age of hardwood floors or battleship linoleum coverings, school floors can easily be kept clean by pneumatic sweepers, oil mops or brush brooms. When the latter is used, a small amount of sawdust, previously moistened and sprinkled over the floor area, will eliminate the dust hazard. Here may be given an instance of the benefit of the filtering of large volumes of air introduced into a building when mechanical ventilation is installed. The air is drawn into and through a system of cotton bags about thirty feet in length in which the dirt and dust are retained. About a peck a month is thus collected and consists principally of organic and inorganic matter found in all street dust.

Heating. — While it is true that a proper heating and ventilating system, installed by a scientific engineer, is capable of delivering any temperature, humidity, air volume, and movement desired, yet in practice, due to the ignorance of the custodians who are supposed to operate these contrivances, the final results have not been satisfactory. With such a record of failure the old tried-out system of open windows, combined with radiators, and known as the direct system, has been found to be the most satisfactory, even though it cannot be said to be perfect.

The problems confronted by the engineer in artificial heating and ventilation are many. First he must take into consideration the three hundred heat units and one and one-third ounces of water each pupil eliminates per hour. Then there is the question of the exchange of fresh air, amounting to thirty cubic feet per minute, determined as necessary to relieve each pupil of the heat envelope which surrounds his body. The questions of heat, drafts, odors, dust, humidification, air cooling and washing, as well as the economic factors of labor, fuel, water, fan power, installations, etc., are to be studied. It is the consensus of opinion that the most efficient and economical method of supplying and exhausting the air required by school buildings is by the use of fans.

Kimball states:

"With the vapor, atmospheric, modulating, and vacuum systems the use of the intermediate acting thermostat is most desirable, because it regulates the supply of steam to the radiators and the movements of the mixing dampers in a graduated manner in accordance with the demands for heating. Thus in mild weather but little steam is admitted to the radiators, and the position of the mixing damper is changed but slightly, with more steam being admitted to the radiators and a greater change in position of the mixing damper occurring as the outside temperature becomes lower, the full quantity of steam being admitted to the radiator during extremely cold weather only. Such a method goes far towards eliminating the overheating of the room and discomfiture of the pupils sitting near the radiators.[2]

Heating is a question which goes hand in hand with ventilation and is discussed under Chapter XXV. The purpose of this statement is not to ascribe merit to one system or to another, for as yet, in the writer's opinion,

[1] New York Board of Health Report.

[2] Kimball: *Heating and Ventilating of High Schools*, Bruce Publishing Co., 1919.

the ideal heating and ventilating systems have been not perfected.

Lighting. — Sunshine destroys bacteria. It adds cheerfulness and comfort to the room and automatically encourages cleanliness. While it is true that natural light is not always uniform, on account of the changing seasons of the year, architects and hygienists are in accord in stating that the ratio of window space to floor surface should be at least one square foot of glass to five of floor space. The modern schoolroom, to be

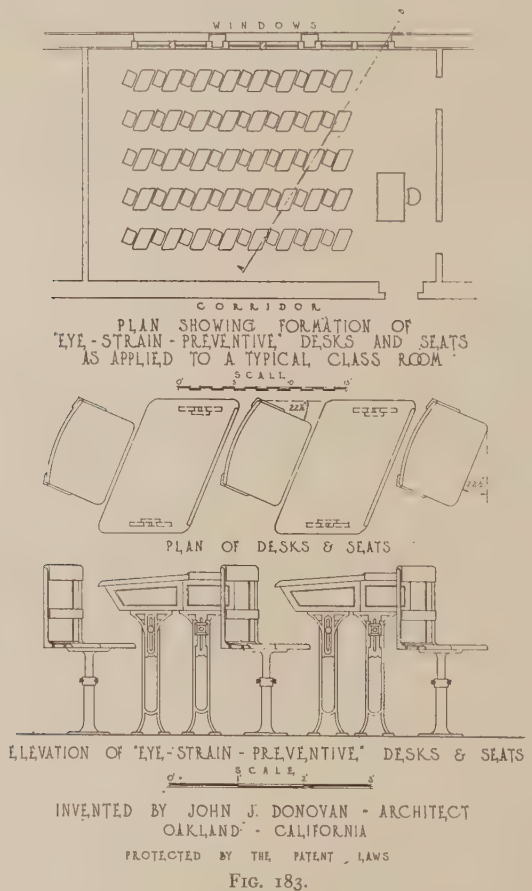

WINDOWS
CORRIDOR
PLAN SHOWING FORMATION OF "EYE-STRAIN-PREVENTIVE" DESKS AND SEATS AS APPLIED TO A TYPICAL CLASS ROOM
SCALE
PLAN OF DESKS & SEATS
ELEVATION OF "EYE-STRAIN-PREVENTIVE" DESKS & SEATS
SCALE
INVENTED BY JOHN J. DONOVAN - ARCHITECT
OAKLAND - CALIFORNIA
PROTECTED BY THE PATENT LAWS

FIG. 183.

evenly lighted, should have a battery of windows, preferably on one side of the room, so arranged that the top of the window reaches within six inches of the ceiling, and, with a ratio of glass to floor space as above stated, adequate illumination is secured. East, southeast, west, and northern exposures afford the best lighting effects. The seating capacity should be arranged so that the rays of light pass over the left shoulder of the pupil, thus overcoming cross shadows and consequent eye strain. To maintain uniform illumination other factors must also be considered. Tall buildings, trees, and smoke from chimneys intercept light. The same is true of dirty windows, as it is known that light passing through clean glass loses four per cent, and through soiled glass, from thirty to seventy per cent of its intensity.[1]

The chapter on classrooms contains a comprehensive discussion of the size of classrooms for the elementary, junior, and regular high schools. The proper ceiling heights are also shown diagrammatically for rooms of different widths in order to obtain the most favorable lighting for all the desk tops. From the data presented in that chapter it is evident that to establish arbitrarily sizes of classrooms, without taking into consideration other facts, is like prescribing a cure-all for special cases. For instance, besides knowing the number of pupils that are to occupy the room, it is necessary also to know the number of rows of desks that are to form the seating arrangement, also the grade of the school. School authorities should take into consideration the scientific facts now at hand for school building. For it is a physical and economic waste to make classrooms all of the same size. The following sizes are given for classrooms which will give the best conditions for lighting, hearing, and vision:

A. Elementary schools, grades I to VI inclusive. Classrooms of five rows of desks (in the width) and of 40 pupils, width 20′ 0″, length 30′ 0″, height 12′ 0″.

B. Elementary schools, grades I to VIII inclusive, classrooms of five rows of desks and 40 pupils, width 21′ 0″, length 31′ 6″, height 13′ 0″.

C. Junior high schools, grades VII to IX inclusive, classrooms of five rows of desks and 35 pupils, width 22′ 0″, length 30′ 0″, height 13′ 0″.

D. Junior high schools for classrooms of six rows and 36 pupils, width 25′ 0″, length 27′ 0″, height 14′ 0″.

E. High schools, classrooms of five rows and 30 pupils, width 22′ 0″, length 27′ 0″, height 13′ 0″.

F. High schools, classrooms of six rows and 30 pupils, width 25′ 0″, length 25′ 0″, height 14′ 0″.

(The above measurements do not include space for wardrobes.)

The walls of the schoolroom should receive careful attention, not only for the purpose of adding cheerfulness to the room where the acquisition of knowledge and ideals is to be encouraged, but also to make the atmosphere healthful and restful and to add warmth and light to the surroundings. The tints that harmonize with most woods are the soft tones of buff, yellow, and orange, which improve the lighting effects without causing glare and the resultant eye strain. The color of the ceilings should usually be of a lighter tint, which will reflect the greatest amount of soft light. On bright days the use of shades becomes necessary to eliminate the glare. The best shades are Venetian blinds or the roller translucent shades of an ecru color.

Desks. — How very little attention is given to the place where the growing child is confined for several

[1] Geyser: *Loss of Light.*

hours each day! It is a matter that should concern all interested in health and education, if they wish to prevent eye strain and postural defects. The question of first importance is to provide adjustable desks, so that the desk and seat fit the child, and not attempt the opposite. At each school term the duty of the teacher should be to assign each pupil to a perfectly adjusted seat and desk. Hygienic requirements for a proper adjustable desk are as follows: the top of the desk should be on an incline of not more than fifteen degrees and about fifteen

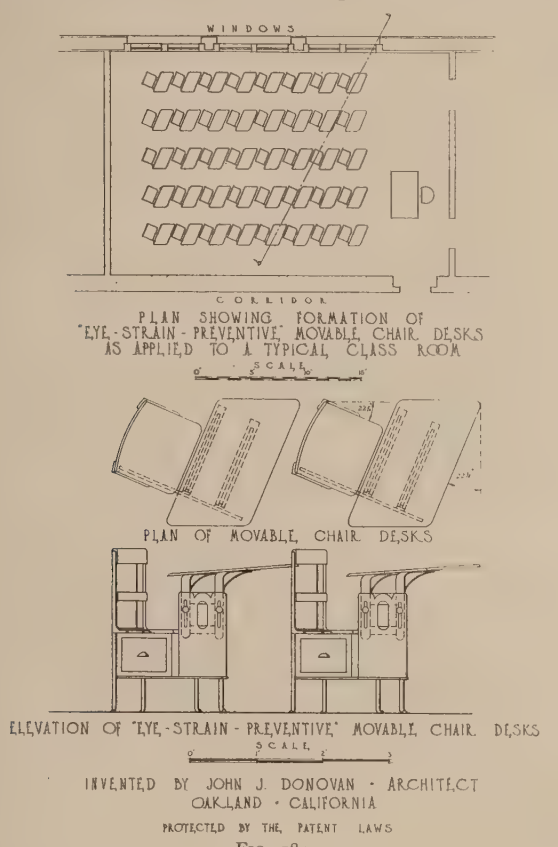

WINDOWS
CORRIDOR
PLAN SHOWING FORMATION OF "EYE-STRAIN-PREVENTIVE" MOVABLE CHAIR DESKS AS APPLIED TO A TYPICAL CLASS ROOM
SCALE
PLAN OF MOVABLE CHAIR DESKS
ELEVATION OF "EYE-STRAIN-PREVENTIVE" MOVABLE CHAIR DESKS
SCALE
INVENTED BY JOHN J. DONOVAN · ARCHITECT
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Fig. 184.

inches from the eye. This allows sufficient slope for a proper posture for vertical writing and permits the eye to fall nearly perpendicularly upon the printed page. The light should be over the left shoulder, as has been already stated. Desk tops should be free from unnecessary gloss and should overhang the front of the seat from one to two inches. The height of the desk should be sufficient to allow the forearm to rest comfortably without much resting on the elbows, so that the scholar will not be required to bend down to write. When the desk is too high, the arm is raised, tending to produce a lateral curvature of the spine known as scoliosis. When the desk is too low the shoulders are stooped. The distance between the back of the seat and the edge of the desk should permit sufficient room not to press the abdomen.

The seat when adjusted to the child forms a right angle of the thigh with the legs, the pelvis resting slightly backward in a concave seat to keep the pupil from sliding forward while the feet are being wholly supported on the floor. To overcome fatigue the seat should have a back reaching below the child's shoulder-blades and arranged to support the small of the back. The author of this book has invented an adjustable rhomboidal form of desk with certain original features which enables

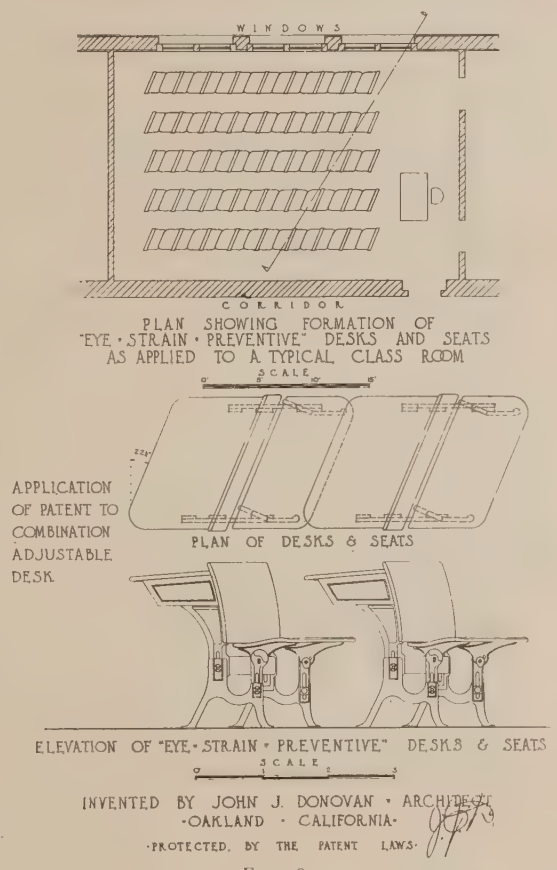

WINDOWS
CORRIDOR
PLAN SHOWING FORMATION OF "EYE-STRAIN-PREVENTIVE" DESKS AND SEATS AS APPLIED TO A TYPICAL CLASS ROOM
SCALE
APPLICATION OF PATENT TO COMBINATION ADJUSTABLE DESK
PLAN OF DESKS & SEATS
ELEVATION OF "EYE-STRAIN-PREVENTIVE" DESKS & SEATS
SCALE
INVENTED BY JOHN J. DONOVAN · ARCHITECT
·OAKLAND · CALIFORNIA·
·PROTECTED BY THE PATENT LAWS·

Fig. 185.

the pupils to sit at a pronounced angle removed from the glare of the window lighting and, at the same time, permits a more direct view of the teacher and obviates the turning of the pupil's head or the change of his position.

Plumbing. — In our city schools, where running water and sewerage facilities are available, this subject should be given attention. It is a maxim that the best is the cheapest. The so-called sanitary plumbing is controlled and inspected by the authorities as to drainage, traps, vents, etc., but the placing of the fixtures, whether they be installed in the basement or on the different floors, is a matter which should be given some consideration.

The better method is to distribute the toilets on the different floors, especially if the building is of more than two stories. The division should in general be according to the following order, five-eighths of the total number on the ground floor, and the remaining three-eighths distributed on the floors above. The ground floor toilet rooms should be adjacent to the playrooms and directly accessible to the play yards. It is obvious that the greater number of toilets should be installed on the ground floor, as the pupils in the elementary schools are marched to the ground floor at the end of each session, and it is at this time that the greatest necessity for toilet service is reached. It is just as obvious that pupils should not be compelled to walk down and up two or three flights of stairs during class hours in order to use the toilet rooms. Therefore each floor should have its toilet rooms for boys and for girls.

FIG. 186. — PROTECTED TYPE OF DRINKING FOUNTAIN

Toilet rooms should be of hard plaster or tiled walls, and the floors made of asphalt, tile, terrazza, or some other impervious material. The important necessity in arranging toilet rooms is to have outside screened window ventilation and to keep them dry and clean. They too should be built of impervious materials. The number of toilets required by girls should be in the proportion of one for every twenty, while for boys one in twenty-five is all that is required.[1] The danger of infection from toilet seats in schools is practically nil, but this fact should not be made an excuse for not cleaning them frequently. There are many so-called disinfectants on the market, which claim to destroy all kinds of germs, but their only merit is their deodorizing power.

All toilet rooms should be mechanically ventilated by allowing fresh air to enter through the open windows and the foul air to be removed through a raised vent in back of the water closet fixture. The back vent has an area of about eleven square inches and protrudes into the utility chamber back of the fixtures. Connected with the chamber there is usually an underground duct leading to a suction fan which draws the air from the toilet rooms and expels it into the open air above the roof. This ventilation is also extended to the urinals by connecting 3″ vent pipe to the urinal waste just above the trap and projecting it 6″ above the floor of the utility chamber. This chamber is likewise connected to the exhaust fan. By this means of exhaust ventilation the movement of the air of the toilet room is always downwards and through the fixtures. The system is fully illustrated in the chapter on plumbing. It should be noted, however, that very often custodians of schools will shut down the fans in order to save a slight expense in their operation. This should not be tolerated, as it endangers health merely for a small saving in money.

In the boys' toilet room upright urinals, concave, of vitreous china, with the drain at the floor and having an automatic flush, are the most sanitary. The number installed should be one for each twenty-five boys. The urinals should be scrubbed daily with brushes and can be deodorized with a solution of chlorinated lime or of creolin, in the proportion of four ounces of the chemical to a gallon of water.

The number of lavatories should be about one to every fifty pupils. They should be equipped with a water-pressure closing valve. This operates by pressing downward a lever, and as the flow of water can be regulated to run from ten seconds to a longer period it enables the child to cleanse his hands without having to touch the metal a second time.

When the old roller towel and the common drinking cup, the two evils responsible for most disease dissemination among school children, were legally condemned in most states, it became necessary to devise sanitary substitutes. Even the first sanitary drinking fountain had to undergo changes on account of epidemics being traced to its faulty construction. In the first designs that were invented, the nozzles were not protected, and the consumer touched his lips to the same, thereby making possible the infection of the water supply, as borne out by investigations recently conducted at the University of Minnesota.[2] Figure No. 186 shows the protected type of drinking fountain nozzle. The water flows in the form of an arc from which the consumer drinks without contaminating it. This type of drinking fountain illustrates the most sanitary drinking fixture on the market.

The number of drinking fountains should be apportioned about as follows: for schools of more than five

[1] Rules: Minnesota Department of Education, School Buildings, 1918

[2] U. S. Public Health Reports.

hundred pupils there should be placed in the playrooms and play yards one for about every seventy pupils, and, for schools of less than five hundred pupils, the ratio should be materially increased. In addition to those for the playrooms and play yards there should be two separate fountains of single jets placed in the corridors of each floor of the building. This will be more convenient and save time on the part of the pupils and will benefit the discipline of the school. It is a good plan to have these isolated fountains connected to wet fire standpipes as indicators of the conditions of these lines for immediate service.

FIG. 187. — BOY DRINKING FROM UNPROTECTED TYPE OF DRINKING FOUNTAIN.

FIG. 188. — BOY DRINKING FROM A PROTECTED TYPE OF DRINKING FOUNTAIN.

Open-air Schools. — Since the open-air school movement was first started at Providence, R. I., in 1908, and the successful promotion and standardization of these methods by the McCormick Memorial Fund at Chicago, it has progressed beyond the realm of the faddist. These schools have been organized all over the country, irrespective of climatic conditions. The aim of the open-air school was primarily to educate, in the fresh air, children who were weak or diseased. Thus cases of bone and pulmonary tuberculosis, glandular enlargements, cardiac diseases, debilitated and anæmic, as well as underfed, children were treated. Every new schoolhouse should have at least one room built especially for an open-air class. This classroom should be located so as to possess a southern and an eastern exposure and should be provided with casement windows which admit the maximum amount of fresh air and sunshine. A room originally built for this purpose has advantages over roof classrooms, on account of the provision afforded against inclement weather.

The temperature of these rooms should never be permitted to rise above fifty degrees Fahrenheit, provided the outdoor temperature is below this. Much lower temperature can be tolerated by children, provided winds are controlled by partially closing them out, as occasion demands. Steam radiators offer the ideal method of heating when the temperature is very low. At the McCormick Open Air School Esquimaux suits and sleeping bags form a part of each child's equipment for keeping warm. The next factor in the successful care of this class of children is to provide in an adjoining room facilities for preparing nourishment. Such a room may serve also as a laboratory for domestic science classes, and may develop into an important feature for the promotion of the "penny lunch" movement which is gaining advocates in our largest cities.

Lunches can be provided here as well as the ten and three o'clock extra feedings. The classroom may be used as a rest room at the period between eleven and twelve by providing the necessary folding cots and blankets. In many of our larger cities a special room is set aside for this purpose. As fatigue must be overcome, the rest period is essential for success. The

Mr. John J. Donovan, Architect.

FIG. 189. — OPEN AIR CLASSROOM, LELAND STANFORD JR. UNIVERSITY ELEMENTARY SCHOOL, PALO ALTO, CALIFORNIA.

staff consists of a teacher, school nurse, maid, and the visiting doctor. Not more than twenty-five pupils should be entered in each class. The teacher should be thoroughly in sympathy with the movement and possess a special knowledge of hygiene and physical education. The resident nurse records daily temperature, takes measurements and weight, and inspects for disease, cleanliness, and proper clothing. She also visits the homes of her pupils, instructs the parents, follows up cases and recommends for operations and treatment. The medical inspector makes periodical physical examinations, recommends and informs parents of the necessity of remedying defective teeth, enlarged tonsils, and adenoids. The benefits of the open-air school from an educational standpoint are that these children progress more rapidly and their attendance and deportment are better. The physical results are that their nutrition and weight improves, the hæmoglobin scale advances, arrested cases of tuberculosis have no relapses, and the nervous and cardiac cases improve markedly. Such a record of success should make it compulsory for each school to possess one or more of these open-air classrooms.

Figure 191 shows an economical arrangement for an open-air suite which is applicable to any school building. This is arranged so that two classes may be maintained — one studying while the other is reclining, and alternating in the use of the room. The wardrobe off room A is for girls, with its shower and toilet facilities and a storage space for lockers containing the sleeping bags and clothing. Similarly the wardrobe off room B is for the boys. It should be noted that such a plan, if adopted, should be placed on the top floor of the building. This scheme will provide for the two classes without any great additional cost over that of two regular classrooms.

Health and Safety Welfare. — The necessity of safeguarding the health and well-being of our children should be indelibly impressed upon the minds of the public servants of the people. If every teacher and every custodian of our schools had had a course in school and child hygiene they would automatically develop

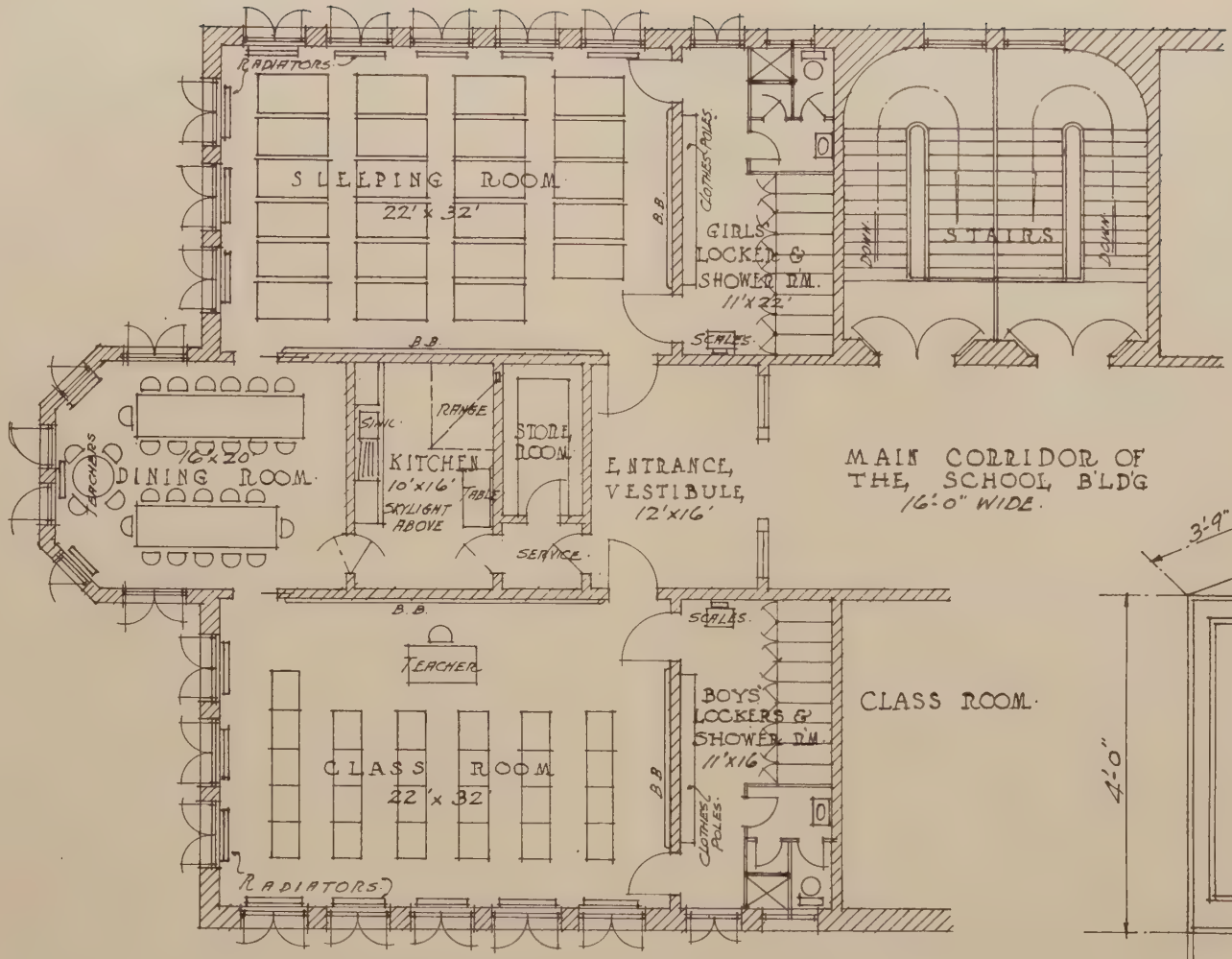
Mr. Wm. Templeton Johnson, Architect.

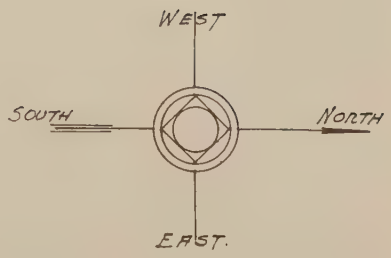
FIG. 190. — OPEN AIR CLASSROOM, FRANCIS W. PARKER ELEMENTARY SCHOOL, SAN DIEGO, CALIFORNIA.

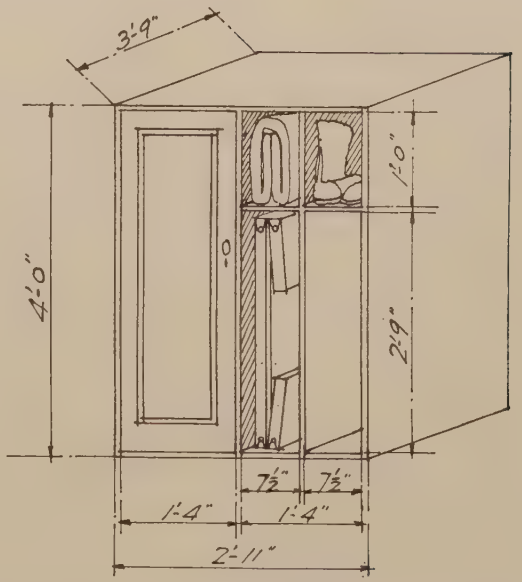
into custodians of the public health. We desire that our children shall learn the fundamental laws of personal health and practice them while in school, for it is at this impressionable age that their ideas become deeply ingrained, and they will not later tolerate inadequate facilities in their homes or workshops.

Every teacher should be a diagnostician of health. When a child deviates from the normal he should become a suspect of disease. With such a knowledge, how easy it is to suppress an epidemic by sending a suspected child home before it has had an opportunity to infect others. It should be the teacher's duty to observe whether a child is becoming blind for want of proper glasses or deaf on account of adenoids or enlarged tonsils. Many a defect taken in time has been thus remedied easily, and cases of communicable disease discovered and isolated. The employment of a school doctor, dentist, and nurse is an economic asset to every school community. When the state by authority is given the right to compel attendance at school, it also has the added duty and responsibility of insisting that no harm shall come to those who go there. By the assumption of this responsibility practical health supervision will have been accomplished.

In Chapter I, " Sites and Grounds," it is pointed out that the intermediate or junior high school should be the center of an area containing a number of elementary schools. Geographically this is the proper place to locate the general school clinic, as shown in figure 192. For it would then serve the maximum number of children most conveniently. The central clinics should care for the medical needs of about fifteen or eighteen schools of a total enrollment of about nine to twelve thousand pupils. Accordingly, in a city of two hundred thousand population and having a school enrollment of about thirty thousand, there should be two or three such clinics.







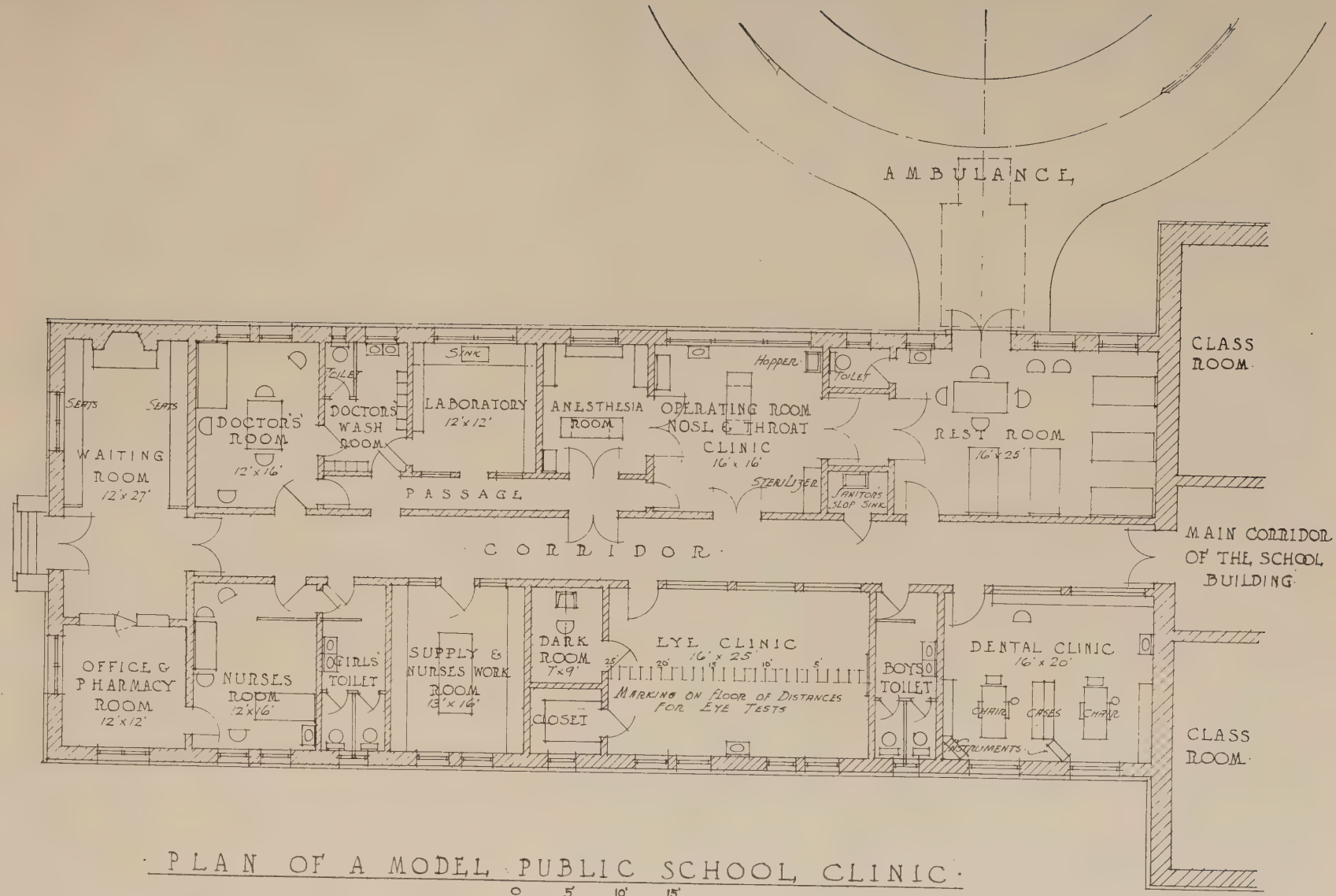
·PLAN OF AN OPEN AIR CLASS ROOM UNIT·

0 5' 10' 15'

SCALE

·VIEW OF LOCKERS·

FIG. 191.



PLAN OF A MODEL PUBLIC SCHOOL CLINIC.

FIG. 192.

Fig. 193. — University of California's Dental Clinic.

The purpose of the school clinic is to make physical examination of the school children of the district, to protect the healthy from the unhealthy, thereby preventing communicable diseases, to discover eye strain, deafness, defective teeth, diseased tonsils, and adenoids, and to recommend to the parents measures for their relief. Often by such examination incipient tuberculosis, anæmia, malnutrition and cardiac cases, which have been overlooked by the parents or the family physician, are noticed, and by proper treatment and open-air schools a future citizen is saved for the state. Mental defectives and stammerers also are thus located and assigned to special classes.

All children after convalescing from an infectious disease, before being allowed to return to school, could be "cleared" or granted permits from the clinic. By coöperating with the Board of Health communicable diseases would be reported and epidemics controlled or prevented. It is surprising how many cases of myopia, squint, and infectious eye diseases are discovered upon periodical medical examinations. Such children are usually behind in their class work and would suffer impaired vision or lose it for want of glasses and proper treatment. The same is true of discharging ears, leading to deafness, enlarged glands, defective mouths and speech, and focal infections, the results of diseased teeth, tonsils, and adenoids. Many of our large cities have free dental clinics for school children, given by philanthropists, notably the Forsyth at Boston, Massachusetts.

The plan for a model public school clinic, as shown above, may be arranged to suit the conditions of the school site. It may be annexed to the main building or be located on the ground floor or in a special building. The pupil enters at one end of the clinic and applies at the office for assignment, and then waits his or her turn in the waiting room. The records of all the pupils of the districts are kept in the office; a spot map hangs on the wall showing the various squares of the city, with colored pins inserted to indicate such prevalent contagious diseases as are daily reported by the health officer. The nurses' room off the corridor

is for their private use. Here the district school and duty nurse reports and receives orders. Adjoining is a room where nurses may conduct special examinations or use for any other purpose deemed advisable. The eye clinic, which is used for testing the hearing as well as the eyes, is arranged with floor markings of one to twenty feet from the Snellen test card, affording a rapid and accurate means of recording vision. The normal vision, being twenty feet from the card, reads 20/20ths, while a child standing on the ten-foot mark, and able to see clearly the lines of letters, would have 10/20ths, or half vision.

For hearing, the examiner may use the same floor scale. The child stands twenty feet away, one ear turned directly toward the examiner, the other ear having been stopped up so as to admit no sound. The examiner whispers in an audible tone of voice. If the child hears at this distance of twenty feet, his hearing is normal and is recorded as 20/20ths. If unable to hear what is said, he moves nearer until able to distinguish the words spoken, and his hearing is recorded at that distance, as, for example, 16/20ths. A dark room for special eye cases is off the clinic. The testing rooms may be used also for vaccinations, examining for vermin, prevalent infectious diseases, or as a small classroom for hygiene talks and conferences.

No school clinic is complete without a dental department for the examination and care of the teeth. According to Gulick and Ayers from 80 per cent to 96 per cent of school children require dental attention.[1] The University of California installed two chairs with complete outfits, costing about $1600, and engaged two full time dental surgeons who keep the hours completely filled during visiting periods.[2]

The school doctor has his private room for special examinations and conferences with parents, also an operating room with the special rooms necessary for high-class work, such as a laboratory, and anesthesia rooms adjoining it. The operating room is for the purpose of administrating first aids, for vaccination dressings, and for tonsil and adenoid operations. A rest room containing a few beds for emergency cases, waiting to be sent home for the family physician to attend, or for cases of fainting or minor injuries, as well as for tonsil operation patients, is also provided. The modern school built to-day must be planned to remain modern to-morrow, as we all agree that grandfather's school was never built to furnish the curriculum and appurtenances of modern health and education.

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[2] *Health Insurance*, University of California, by Robert T. Legge, M.D.

CHAPTER X

PHYSICAL EDUCATION

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Introduction. Need of Physical Education. History of Physical Education. Rise of the Playground Movement. New Era in Physical Education, 1914–1918. State Laws. Definition and Aims of Physical Education. Periods of Leadership and Instruction in Physical Education. Phases of Physical Education. Physical Education in the Curriculum. The Physical Education Plant. The Indoor Gymnasium. Room for Corrective Gymnastics. Game Room. Swimming-Pools. Outdoor or Semi-outdoor Gymnasium. The Play Yard. Elementary School. Intermediate School. High School.

Introduction. Need of Physical Education. — A number of circumstances have brought out in the past decade the great need for physical education in our public schools. Perhaps the greatest revelation was due to the examinations of men for entrance into the army in our country, as well as in all other countries engaged in the World War of 1914–1918. The following statistics give the number of men rejected for service in the army in one large section of the United States.

Total called	3,082,946
Total examined by local boards	2,510,706
Total rejected	730,756
Per cent of those rejected after examination	29.11
Add 5.8 per cent of number sent rejected at cantonments	33.19

Eugene Lyman Fisk, Medical Director of the Life Extension Institute, New York City, writing in the American Medical Association Journal for February 2, 1918, says: "The most superficial analysis shows very clearly that at least sixty per cent of these rejected men owe their impairments either to ignorance or neglect. The man who has a remediable defect and hides behind it is really a slacker, although he may not be conscious of it. Forty per cent of the men between the ages of 21 and 31 are physically unfit. It must be remembered that the majority of these men were not declined because of surgical defects. They need physical training and hygiene and proper diet."

Another evidence of the need for physical education is brought out by Provost Marshal General Crowder, who says: "Perhaps the most glaring fault noted in aspirants to the Officers' Reserve Corps and one that might be corrected by proper attention in our high schools, preparatory schools and colleges, might be characterized by the general word 'Slouchiness' . . . "At military camps throughout the country mental alertness, accuracy in thinking and acting, clearness in enunciation, sureness and ease of carriage and bearing must be insisted upon for two reasons — that success may be asserted as nearly as human effort can guarantee it with the material and means at hand, and that priceless human lives may not be criminally sacrificed. Only by the possession of the qualities referred to does one become a natural leader."[1]

Another cause for the rise in the physical education movement has been the rapid development in the use of machinery for all types of work in city and country, together with the movement toward the concentration of our population in large cities. The physical exercise in connection with our daily work has become less and less and the strain which has been put upon the workers by speeded up production has become greater and greater. Use of the small muscles rather than the big muscles in this finer type of work necessitated by greater coördination has been a contributory cause. The results are beginning to show in the effect upon the health and efficiency of our people. The need for vigorous physical activity is being felt by all, and the feeling is growing that these activities must be guided through the school years of a child in order that proper health habits may be established.

A concrete example of the strain which modern civilization is placing upon the individual is shown in the heavy increase in nervous diseases in the past decade. This has been accompanied by a very decided decrease in the number of contagious diseases. This seems to be an indication that although we are mastering the diseases that are spread by infection, we are failing to cope with those which are caused by high nervous strain. It would probably be impossible for any one cause to

[1] Extracts from letter written by the Adjutant General's office, Washington, August 28th, 1917.

be assigned for this increase in nervous diseases, but it seems reasonable to assume that the high strain of working long hours indoors under nerve-racking conditions, together with the absence of vigorous physical exercise in the open air and proper rest for recuperation, is responsible for part of this situation.

A general wave of opinion has swept the country in favor of a thoroughgoing system of physical education for the boys and girls of the elementary and high schools.

History of Physical Education. — Physical education in one of its many forms has been evident in the educational system of all the leading peoples. In England it has largely taken the form of a vigorous play and game life among the children, and this has also been evident in the activities of the adults. The majority of the games which children play, and especially those which they continue to use through life, are games which have come to us from our Anglo-Saxon ancestors, for instance, the games of tennis, handball, golf, football, soccer, lacrosse, cricket. Even baseball in an early form has come down to us through England. Their motto of "Sport for sport's sake" has become axiomatic the world over.

The Swedish system of physical education, perhaps the most elaborately worked out system by which large numbers can be handled in limited space, is to-day the basis of a great deal of our established work.

The German system of physical education brings us to an entirely new viewpoint in the work. Their system was largely stimulated by the conditions which were brought out in the Franco-Prussian War. The object of their work was to develop physical stamina in the young men of the Empire that they might be better able to serve the Fatherland. The work turned rapidly to gymnastics, best illustrated by the work of the Turnvereins. Their work was largely individual, and with the exception of broadswording, dueling and certain types of combative exercises, there was little of the social element manifest.

In America as early as 1821 an outdoor gymnasium was established in Salem, Mass. In 1825 Harvard, Yale, Amherst, Williams, and Brown had established gymnasium courses. After this, for a number of decades, the enthusiasm for physical education died down. The next wave of enthusiasm was manifest during the decade following the Civil War. It is said that a school which had for a phase of its activity play and physical education was started in the old First Church of Boston in 1866, and two years later when the church moved to its new home at Copley Square an outdoor playground was added near by.

Rise of the Playground Movement. — Little progress, however, was made during that decade or the next. The revival of the interest has been closely associated with the rise of the playground movement, which may properly be dated from 1890. During that year a number of small playgrounds were opened and in New York $25,000 was set aside for playgrounds. Many associations were taking up the subject of playgrounds, largely from the standpoint of charity, as the play movement was supposed to benefit only the children who were living under slum conditions. The names of Jacob A. Riis, Theodore Roosevelt, and Joseph Lee were closely associated with the work at this time.

With the beginning of the twentieth century new developments took place rapidly. Dr. Luther H. Gulick organized the Public School Athletic League, and leagues of this type were established in many cities. Playground and recreation associations were formed distinct from charitable organizations. Among the notable private organizations should be mentioned the one of Pittsburgh, Pa., which for many years was directed by Geo. E. Johnson.

The movement rapidly spread westward and began gradually to take a new form. The private associations gave way to municipal control, and the movement was taken over by one or another of the various city departments. As a rule, it was a department of the park commission, as the park commissions already had control of large areas of open land throughout the cities.

This phase of the movement lasted only a few years, as the fast growing work became too complicated for a department of the park commission. The playground commissions were soon organized as a part of the municipal government, and practically every city in America to-day has in one form or another a playground or recreation commission which conducts play for children after school and during vacations.

New Era in Physical Education of 1914–1918. — With the rise of the present physical education movement, which may be dated from the war of 1914–1918, the next logical step which should be taken is actually being taken, namely, all types of physical education are being taken over by our educational system and made compulsory by our public schools. It was necessary to show the community the value of this work exactly as the early church schools showed the community the value of education, but now that the community is convinced of its value the responsibility of the work is properly being assumed by the public schools. There are a number of reasons why this must be so. 1. The school has all the children. Upon a voluntary basis of education or physical education those who are the most progressive and need it the least will take advantage of the opportunities. The place where the need is greatest is not reached when the work is on a voluntary basis.

2. The school should have the ground and other facilities necessary for physical education. If the physical activities for the children are centered about the school, it will be unnecessary for a municipality to duplicate ground and equipment. The step that has been taken by a large number of the states in making this work a phase of the school work is the logical step.

This does not mean that the playground and recreation associations or commissions have completed their work. The emphasis of their work will be merely *shifted from that of the children of the community to the adults of the community*, which is a very large and complicated field.

State Laws. — Extracts from a number of State laws on this subject are here given:

California State Law
Senate Bill No. 599
Chapter 668
An act to provide for the organization and supervision of courses in physical education in the elementary, secondary and normal schools of the state, and appropriating ten thousand dollars therefor.
(Approved May 26, 1917.)

"The people of the State of California do enact as follows:

"Section 1. The board of education of each county, city and county, and city, whose duty it is to prescribe the course of study for the elementary schools of such county, city and county, or city, shall prescribe suitable courses of physical education in accordance with the provisions of this act for all pupils enrolled in the day elementary school except pupils who may be excused from such training on account of physical disability; and the high school board of each high school district shall prescribe suitable courses of physical education in accordance with the provision of this act for all pupils regularly enrolled in the day high schools of such district, except pupils regularly enrolled in high school cadet companies and pupils who may be excused from such courses on account of physical disability.

"Section 2. The aims and purposes of the courses of physical education established under the provisions of this act shall be as follows: (1) To develop organic vigor, provide neuro-muscular training, promote bodily and mental poise, correct postural defects, secure the more advanced forms of coördination, strength and endurance, and to promote such desirable moral and social qualities as appreciation of the value of coöperation, self-subordination and obedience to authority, and higher ideals, courage and wholesome interest in truly recreational activities; (2) to promote a hygienic school and home life, secure scientific supervision of the sanitation of school buildings, playgrounds and athletic fields, and the equipment thereof.

"Section 3. It shall be the duty of the superintendent of schools of every county, city and county, or city and of every board of education, board of school trustees, or high school board, to enforce the courses of physical education prescribed by the proper authority, and to require that such physical education be given in the schools under their jurisdiction or control. All pupils enrolled in the elementary schools, except pupils excused therefrom in accordance with the provisions of this act, shall be required to attend upon such courses of physical education during periods which shall average twenty minutes in each school day, and all pupils enrolled in the secondary schools, except pupils excused therefrom in accordance with the provisions of this act, shall be required to attend upon such courses of physical education for at least two hours each week that school is in session. . . ."

State Law of New York
Chapter 567
AN ACT to amend the education law, in relation to courses of instruction in physical training and discipline in the schools of the state.

Article 26-A
Discipline and Physical Training.

"After the first day of September, nineteen hundred and sixteen, all male and female pupils above the age of eight years in all elementary schools shall receive as part of the prescribed courses of instruction therein such physical training as the regents after conference with the military training commission may determine, during periods which shall average at least twenty minutes in each school day.

"Similar courses of instruction shall be prescribed and maintained in private schools in the state, and all pupils in such schools over eight years of age shall attend upon such courses; and if such courses are not so established and maintained in any private school, attendance upon instruction in such school shall not be deemed substantially equivalent to instruction given to children of like ages in the public school or schools of the city or district in which the child resides."

State Aid for Teachers Employed. — "The commissioner of education, in the annual apportionment of state school moneys, shall apportion therefrom to each city and school district on account of courses of instruction as provided in this article, established and maintained in the schools of such city or district during the school year or any part thereof, a sum equal to one-half of the salary paid to each teacher on account of instruction given in such courses, but the entire amount apportioned on account of a single teacher during a school year shall not exceed six hundred dollars."

Many other states have enacted laws, and national legislation will soon follow.

Definition and Aims of Physical Education. — "Physical education is that phase of education concerned with the functions of big muscle activities and related factors which control the growth and development of the child and the physical efficiency of the adult. Related factors mean behavior or habits influencing diet, sleep, rest, oxidation, elimination, temperature regulation, mental moods, etc. In order that development may be secured there must be protection from handicapping growth divergencies, devitalizing drains, infection, poisons, etc. And in the educational process the individual must come finally to control his own efficiency. Therefore, physical education is interpreted to cover (1) the facilities and organizations necessary for physical training activities, activity being the only constructive factor in developing power; (2) the control of growth handicaps, the preventive and corrective factor in growth and development; and (3) the teaching of efficient living, the self-directing factor, *i.e.*, the gradual establishment, largely indirectly, but finally directly, of an ideal of self-engineering for efficient living.

"The special aims of physical education are determined primarily by the functional or developmental effects of the activities with which physical education is concerned. Physical training activities are (1) the only activities that develop the latent organic powers, or the vitality and the nervous capacity to stand the wear and tear of strenuous living; (2) the only activities that develop the fundamental psychomotor strengths and skills and mental responses; and (3) the activities that most profoundly exercise the deeper instincts and emotions which lie at the foundation of character. The leadership of these activities offers great opportunity for influence in character training and in the development of many fundamental phases of adjustment for citizenship. These are the primary aims in physical education. They are related to other phases of education as the foundation to the superstructure."[1]

Periods of Leadership and Instruction in Physical Education. *Classification of Periods.* (Under School Year Conditions.)

a. Supervised Play period. (Synonyms: directed play period; athletic period; "recreation" period.)

b. Instructional period.

c. Between-class relief period.

d. Special corrective period.

Relationships between the Periods. — *a.* These periods are *all* physical training periods; all are exercise periods; all are periods requiring leadership. They are designed to meet the physical needs of children under the conditions and demands of the modern school organization. The distinctions and relationships between the periods are not intended to be arbitrary or inflexible. Conditions may alter these relationships and distinctions. In general, the descriptions below will hold true.

The Supervised Play Period. (*Athletic period.*) — This period represents the broader organization of physical training activities necessary for the development of organic power and nervous vigor, and for character training, but the time consumed bulks so large that it is impossible usually to organize it entirely within the regular school hours. It covers at least a part of the time before school, during recess, after school, Saturdays and holidays. Therefore this period represents an extension of the educational influences of the school into the outdoor play life of the child; his "free time." It is the period for the broadest leadership, coaching and training in the highest sense, and the systematic-incidental instruction in right living. The school should organize enough of this "free" time to establish play habits and ideals which will function in the play life away from the school's organizing influence. Present-day social conditions influencing child life and education demand that the school shall organize this period in self-defense, because:

a. The influences of the unsupervised play life of the child are balking the school and society in their educational efforts.

b. The unsupervised play of children at home and in the home neighborhood under present-day social conditions is generally neither efficient from a physical training standpoint nor wholesome from a moral standpoint. Surveys show that time is wasted in loafing and fooling, and the activities drift into forms that are physically, morally, and socially detrimental.

c. The difficulties in the organization of efficient play, due to the cramping and complex social conditions in cities and the isolation in the country, are beyond the resources and organizing power of children; they must have help and direction.

d. Parents as a rule do not understand the needs of children as to amount and variety of activity, and they do not possess, usually, the skill to organize the play activities even where they see these needs.

The Instructional Period. — (Do not call this the Physical Training Period and thus narrow the term; it is only one of the Physical Training periods.) This period is the backbone of the physical training program in the school. It comes within the regular school hours and is essentially a period for teaching and practice, as physical training activities must be taught and

[1] California State Manual on Physical Education, by Clark W. Hetherington.

learned. In this period, the teacher takes the initiative and teaches those activities essential for development or for free participation in the supervised play period. The instruction should be scheduled and conducted, so far as the attendance and attitude of the students are concerned, like other school periods, but the instructional purpose should not make the period disagreeable. On the contrary, it should be charged with a purpose and enjoyment. There is no conflict between discipline and the spirit of play.

To be successful the organization of the activities in this period must be progressive, both by age periods and by the skill of groups of individuals. This requires a differentiation of the instructional period into several periods according to grades, or age capacities. Frequently, especially among the older children, it requires an organization of groups within age periods according to ability.

The activities taught and practiced in this period should cover all the groups in the classified list above. It is the period in which tactical and calisthenic drills may or should be taught, but it is not a period for such drills only. It is equally a period for instruction and practice in the more important instinctively impelled activities. The activities should parallel those of the supervised play period — the one from the standpoint of instruction and the other from the standpoint of a broader participation. The one should contribute to and determine the activities of the other. This requires a division of any period according to the number of activities taught, or the organization of several instructional periods through the week for different activities, such as swimming, dancing, etc.

Between Class Relief Period. — This period is distinctly a relief period. It is designed, primarily, to counteract the detrimental influences of sedentary, desk, and mental occupations. Coming between classes it relieves from the fatigue of the class just closed, and freshens for the class to come. The time suggested is not sufficient for the period to rank as a *constructive* physical training period; it simply tends to counteract the bad effects of school life.

" A minimum of two minutes between two sedentary class periods should be devoted to fatigue relieving, or circulation stimulating activities. Gymnastic or setting up drills may be given if the individual teacher is skillful enough to handle drills successfully to get physiological results, and if local conditions make them the only exercises possible. But formalized exercises to command are fatiguing. A brisk run across the school yard, or a run in place is more valuable than a drill incorrectly conducted. Any activity of the classified list which can be conducted with vigor and dispatch for all the children of the group at once under local conditions should be considered legitimate for this period. The object is to stimulate, relieve, and freshen. Where there are long recess periods between classes, they should count as relief periods.

Special Corrective Period. — This period is designed especially for children having structural or functional defects which handicap and which may be corrected by special active or passive movements or exercises. These children must be handled as individual cases and with individual attention, and so far as the defects are concerned, apart from the other periods, hence the special period; but this does not mean that these children should not have the activities of the other periods also where they are able physically to enter into these activities. In many cases they need the activities, organic vigor, strength, skill and character discipline, more than children without defects. The special corrective activities are developmental only in a very narrow sense.

" Participation must be determined in each case by an examination, conducted by a skilled person. Only the expert physical educator or the instructor who has had special training is capable of handling the children and activities of this period. The inexperienced instructor should refer corrective cases to an expert, or to a surgeon." [1]

Phases of Physical Education. — There are a large number of phases of physical education which are being focused under one head. These phases have been called athletics, calisthenics, military training, folk dancing, play, hygiene, medical inspection, etc. These various branches have in the past been operated more or less independently of each other, but in an educational system it is very essential to unite them into a comprehensive plan.

The modern viewpoint of physical education is indebted to Clark W. Hetherington for the classification of activities. The following will in general be based on his classification.

1. *Natural Play Activities.* — These activities include all of the instinctive activities which the child naturally loves. The California Syllabus on Physical Education outlines the following:

a. Self-Testing Activities. — This phase includes all of the stunts beginning with the simple hop or skin-the-cat and leading up to the most difficult exercises on the horizontal bar and parallel bars. This includes what has been known as " heavy gymnastics."

b. Dramatic Activities. — This list of activities takes in all of the games where the imagination is brought

[1] California State Manual on Physical Education, page 19.

into play, and covers the scope from simple action stories to the matter of acting out Mother Goose rhymes and fairy tales.

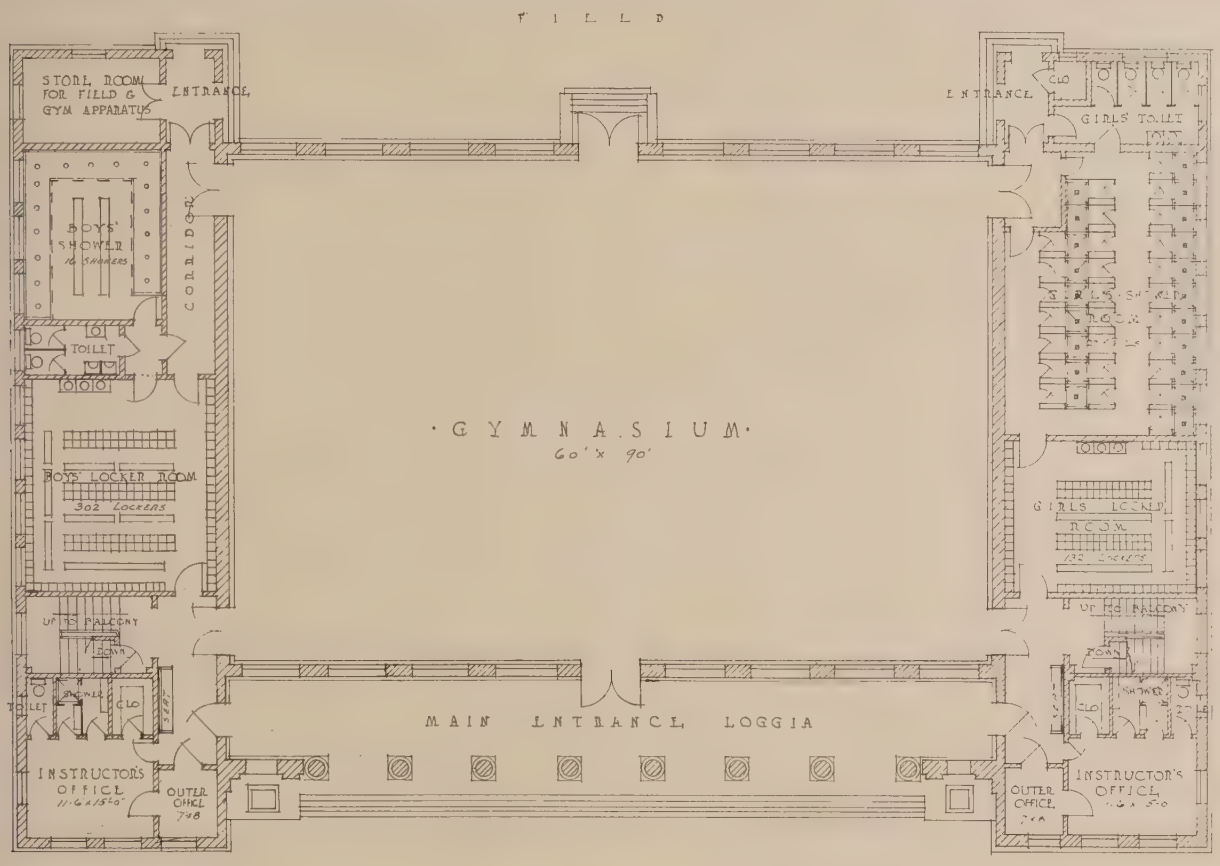
c. Rhythmic Activities. — This class of activities takes in all of the rhythmic work, beginning with the simplest singing games and leading up to the most difficult "folk dances."

d. Hunting Games. — This class of activities takes in all of the list of tag games where one person is "it,"

g. Water Activities. — This type takes in all of the activities which have water as a medium, beginning with wading and leading up to swimming.

h. Winter Activities. — This includes all types of activities which have to do with winter, including skating, sliding, skiing, tobogganing, etc.

2. *Formal Activities.* — This type of activities takes in all of the marching, calisthenics, gymnastic drills, posture instruction, etc. In the past, this has been the



FLOOR PLAN OF A GYMNASIUM BUILDING.

0 5 10 15

SCALE.

FIG. 194.

and begins with the very simplest games of cat-and-mouse, drop-the-handkerchief, etc., and leads up to the more complicated games of prisoner's base, bear line, and games of like nature.

e. Athletic Activities. — This type of activities takes in all of the various forms of athletics, including:

Individual Athletics — track and field events.

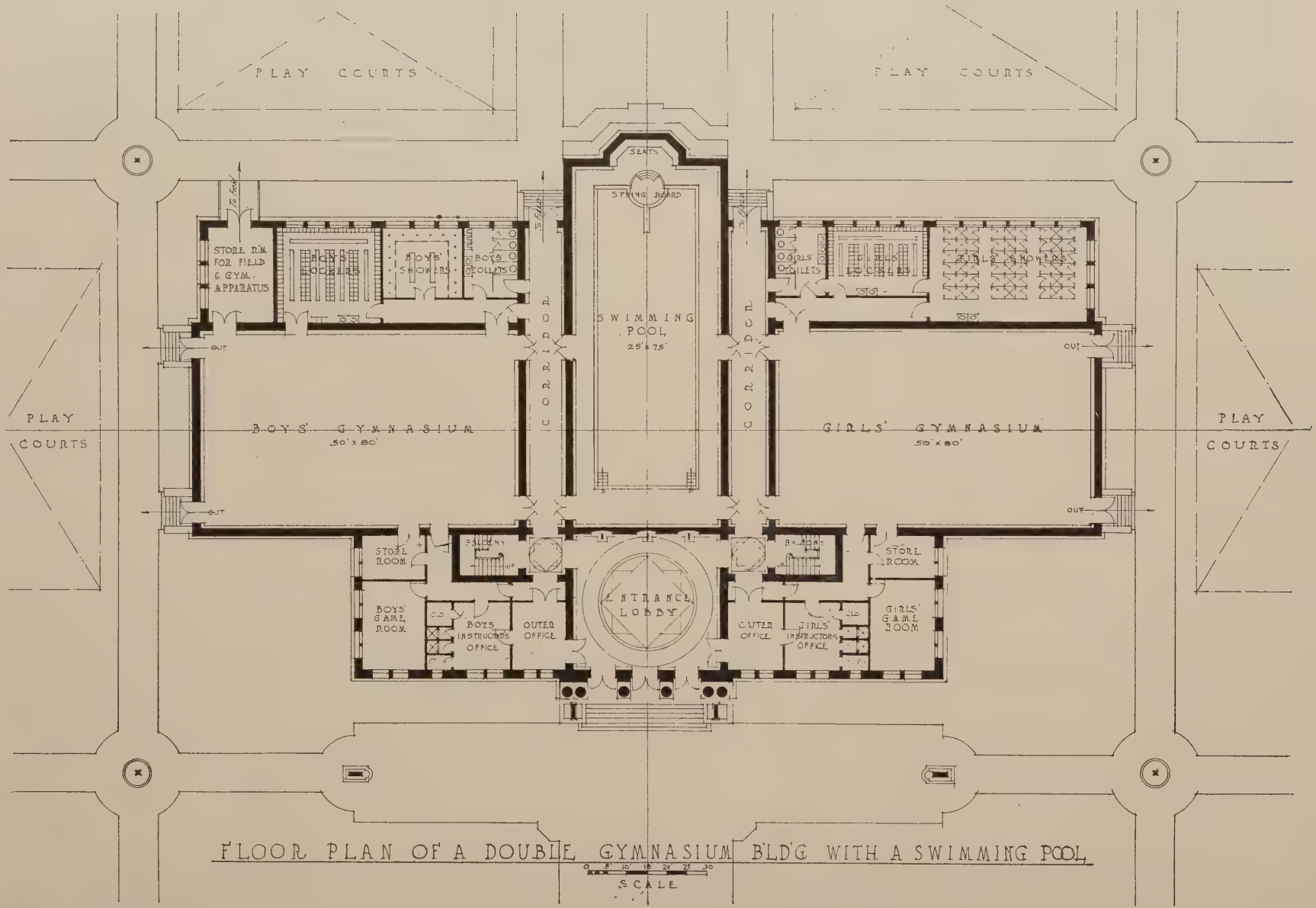
Single or Dual Games — tennis, handball, etc.

Team Games — basket ball, baseball, etc.

f. Personal Combative Activities. — This phase includes all of the activities of wrestling, boxing, fencing, singlestick work, broadsword, etc.

phase that has been known in the minds of many as "physical culture," later, "physical training." At a glance one will see that it is a very narrow interpretation. This interpretation, however, has become so universal that to-day physical education means in the minds of many teachers nothing more than lining children up in the schoolroom and giving them a few formal exercises. This phase of work should not be neglected, but should be properly conducted, as it forms a very important part of the posture and disciplinary training.

3. *Related Activities.* — A large group of related activities is also included under physical education



FLOOR PLAN OF A DOUBLE GYMNASIUM BLD'G WITH A SWIMMING POOL.

FIG. 195.

This group includes all of the outing activities, camping, hiking, etc., in which exercise is involved. The matter of summer camps should become a very large part of physical education for our high school boys and girls.

4. *Teaching Efficient Living.* — The whole phase of teaching efficient living is part of physical education, as it all tends to give the child the proper viewpoint in building himself into a strong and efficient citizen. This has been included in the past under the name of " teaching of hygiene."

5. *Control of Growth Handicaps.* — This has to do entirely with the control of the many types of handicaps under which children labor, including the conditions of eyes, ears, tonsils, adenoids, etc.

6. *Therapeutic Gymnastics.* — All of the various phases of corrective work known as " corrective gymnastics " are included under the head of physical education.

7. *The Playground Movement.* — The whole phase of the playground movement either during the school year or during the summer season is a phase of the physical education program and should be brought entirely under one comprehensive plan.

Physical Education in the Curriculum. *A. Elementary Schools.* — Physical education should be placed in the curriculum with a definite schedule of time from 20 to 40 minutes daily. This period should be distinctly an instruction period. It is a time to teach new activities and to lay the foundation for the entire program. Provision should also be made for the relief period, and one should be planned so that every hour in which the children are in a schoolroom is broken with at least one two-minute relief period. The play period should be at recess, noon, and after school. The bulk of this work will of necessity be done by the grade teacher, but with the aid of supervisors of city or county units.

B. Intermediate or Junior High Schools. — In the intermediate or junior high schools from three to five hour periods weekly should be definitely set aside for physical education instruction. Special instructors should be employed for the boys and girls, as in few instances is it advisable to give the work in mixed classes.

C. High Schools. — The problem in the high schools is entirely the problem of specialists, and a man should be employed for the boys' work and a woman for the girls'. From three to five hour periods weekly should be arranged for in the schedule of classes. Hygiene may possibly be taught in one of these classes, or it may be advisable to give it in a special course. Credit should be given for the work on the same basis as other subjects. Grades based on attitude toward the work, attendance, and improvement of health, should appear on the report cards, and strict graduation rules in regard to physical education credit should be lived up to.

A secretary to the physical directors will be of great assistance. With the proper arrangement of classes the secretary could also do the accompanying work for rhythmic activities.

The Physical Education Plant. — The physical education plant includes all of the equipment required to put into effect a thorough-going physical education program. This will differ somewhat for the high school, the intermediate school, and the elementary school, and will have to be adjusted to meet the needs of the program in the curriculum.

All of the phases of equipment will be considered. Many will be applicable only to the large school. A selection, however, can be made according to the size, needs of the school, money, and space available.

The Indoor Gymnasium. — The gymnasium can be considered to have three units: the office, with adequate rest room, or administrative unit; the lockers, dressing-room, shower, and toilet unit; the exercise floor or floors.

Figure 194 shows a floor unit, and figure 195 shows the arrangement of three units.

A. Office. — There should be separate offices for the men and women physical directors. Each office should be arranged as follows:

1. An outer office, in which equipment can be placed for a secretary, who will take care of the files, correspondence, statistics, excuses, roll taking, examination blanks, etc.

2. An inner office, in which there should be located an examination room, panel looking glass, dressing room, shower, storeroom, closet with washbowl and toilet, couch, complete first-aid kit and anthropometric apparatus.

In the inner office of the woman director, there should be placed a number of rest chairs and couches, varying with the size of the school. These are for the convenience of the girls necessarily excused from the regular work.

From these offices, easy access should be had to the dressing rooms, gymnasium floor, and if possible, the athletic field, in order that better supervision may be maintained.

Figure 195 carries out these plans.

B. Lockers, showers, toilets and dressing rooms.

I. Lockers. — The locker arrangement depends upon the amount of dressing room space available, as well as on the locker system in use for the regular school work. The following suggestions are given in the order of their preference:

(1) A Gymnasium Locker Placed in the Dressing Room for Each Pupil.— This could be a half-size locker, minimum 12×12×36; thus double tiers could be arranged. With this system all personal equipment can

be placed in one locker and kept there. It, however, means duplication of lockers if the school has a locker system.

(2) Cubical or Fiber Basket System. — In this system there are lockers of the above type provided for a class of minimum size. Each pupil has a fiber basket 13×9×8, which contains his uniform and personal equipment. When not at class these boxes are filed by numbers. On coming to class the pupil gets his basket, carries it to the locker room and dresses for class work, putting his street clothes into the large dressing locker. This system requires the constant care of an attendant. Girls will require a larger basket.

(3) Lockers for a Class of Maximum Size. — This system requires lockers for one class. The personal equipment is brought from the school locker to the dressing room and returned to the school locker after class. The dressing room locker is thus used only during the period.

(4) Keys. — The problem of keys is always a serious one, and probably no system will give perfect satisfaction. The combination lock system results in pupils forgetting the combination, and there is also the danger of one person remembering many combinations. The system of having each person provide his own lock, while quite satisfactory to the user of the locker, makes an inspection of a locker very difficult. Whatever system is employed, it is quite agreed that a system with a master key should be used, and duplicate key, so that the director and custodian may at times inspect the lockers.

II. Showers. — The importance of the shower bath cannot be overestimated. It should follow all strenuous exercise periods, especially intermediate and high schools.

(1) Boys. — The simplest type of shower is preferable for the boys' unit. These showers should be overhead, 8 feet from floor, and operated by simple non-scalding valves which will easily regulate the supply of hot and cold water. The water is heated by a steam coil in the hot water tank, which operates automatically. An auxiliary system may be utilized. It should be supplied with an automatic thermostat which turns off the heat when the water reaches a temperature of between 130° and 150°. The sides of the shower room should be lined with non-absorbent material.

(2) Girls. — The only suggestion over and above those given for the boys' showers is that individual side showers should be used for the girls. Hair-drying machines should be provided. Non-absorbent partitions with canvas curtains should be used. Showers turned on by an attendant are successful.

III. Toilets. — All toilets should be arranged within easy access of an outside entrance, so that they can be used directly from the play yard, as well as from the dressing room.

IV. Dressing Room. — Four-foot aisles between the lockers should be provided in the dressing rooms, and the aisles should be covered with cheap washable rugs or linoleum strips. Complete drawings for the boys' unit as well as the girls' unit are given in figure 195.

The two units above outlined, office and lockers, dressing room, showers and toilet, should be so planned that in case only enough money is available to erect a part of a gymnasium these two units could be erected first. In many parts of the country this is all of the building that will be needed. *The work which is usually done on the gymnasium floor could many times be done in the yard.* This will be true more and more for the future, as most of the physical training activities will be given in the open air, providing proper surfacing and sunshield and windbreaks are provided.

C. Exercise Floor or Floors. — For public school use very little consideration need be given any room beyond the main exercise floor and attendant rooms. Consideration should be given early in the planning in regard to whether there will be a running track, or any large accommodation for an audience.

Running Track. — There is a growing feeling that all running should be in the open air. This should be especially true for school children. If a track is installed, it should be 6 feet wide with curves of not less than 15 feet radius. It should be covered with $\frac{5}{16}''$ cork carpet. A brass sliding pole should be provided from the track to the main floor in order that there may be quick access from track to floor. See figure 196.

Provision for Seating Audiences. — The school gymnasium should not attempt to provide a large seating capacity. Some space may be arranged over the dressing room and office. Collapsible bleachers may be used on the large floor. See figure 197.

Specifications for the Main Floor. — One of the first points to be determined will be the size of the gymnasium floor and the number of gymnasiums needed. One gymnasium should be adequate for a school with an enrollment up to 700. This could be used on alternate days. While the boys use the gymnasium the girls could use the athletic field.

In schools where the enrollment numbers above 700, two gymnasiums should be provided, one for the boys and one for the girls. See figure 195, which gives a suggestion.

Size and Shape of Floor. — Regardless of the number of gymnasiums or the size of the school, the size and shape of the exercise floor will remain very much the same, as it is impracticable to handle more than fifty pupils in any one class. The extra space, of course,

Messrs. Perkins, Fellows & Hamilton, Architects.

FIG. 196. — GYMNASIUM OF PONTIAC HIGH SCHOOL, PONTIAC, MICHIGAN.

makes room for a variety of indoor athletic games, which is always an advantage. Many experts on this subject suggest the proportion of length to width on the basis of 3 to 2. This, however, the writer does not feel is quite according to the needs, as the length should be a little more than the width under this proportion. The following schedule is submitted, which is believed to be better:

Minimum size, 35×65
Average size, 50×80
Maximum size, 60×90

Many gymnasiums, however, will be larger than this.

Height. — Twenty-one feet is many times given as the height for a gymnasium. Other heights, however, have their place in the consideration of the needs of all types of public schools. The following heights are submitted. From the floor to the exposed wood or steel beams overhead:

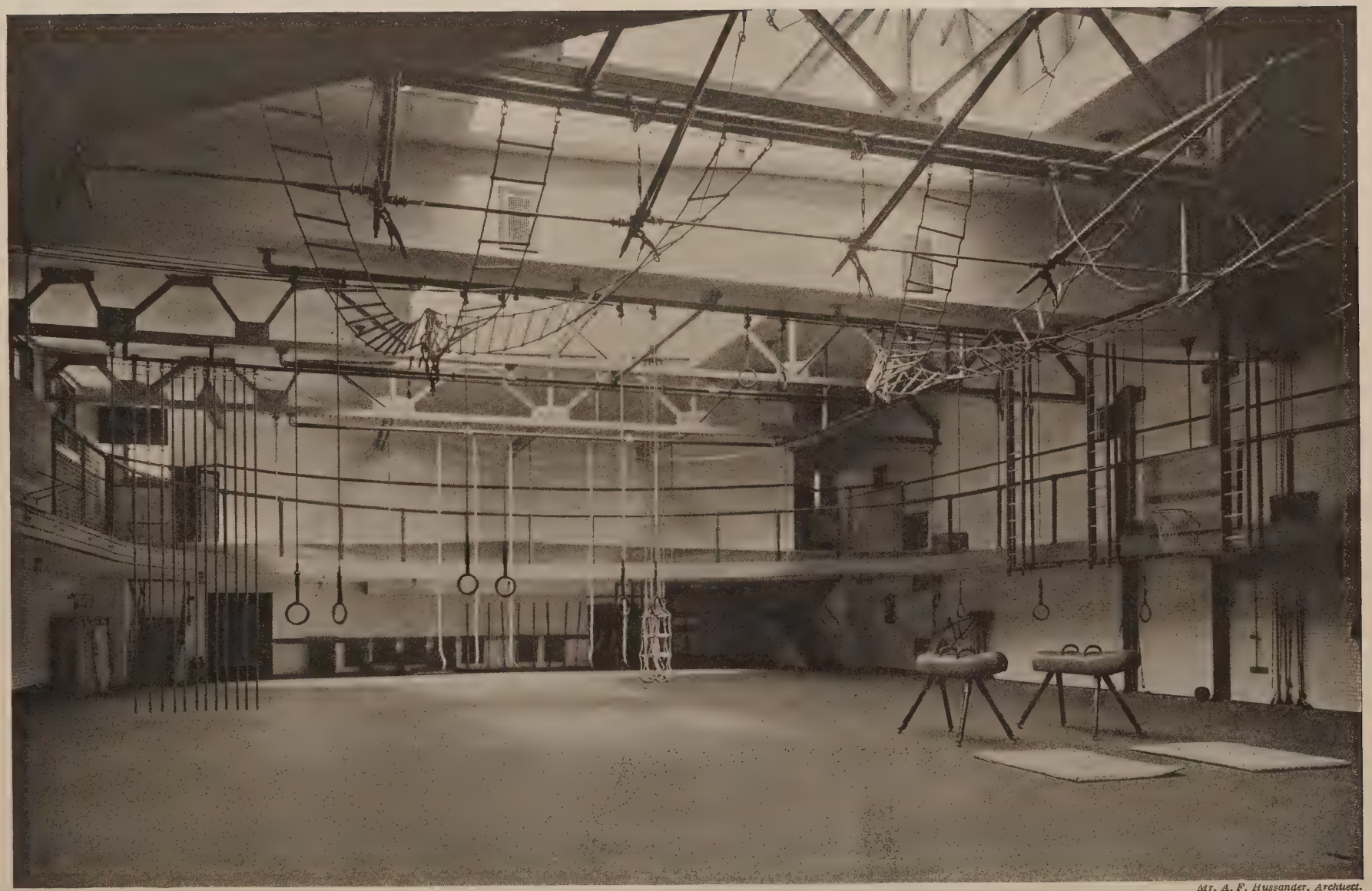
Minimum, 14 feet
Average, 18 feet
Maximum, 22 feet

Roof and Trusses. — Architects should be cautioned against planning the construction of a sloping roof in such a manner that it brings the cross beams out of level with each other, which makes installation of apparatus difficult. The cross beams or trusses should be arranged to accommodate standard pieces of apparatus. The following suggestions are submitted:

Minimum width between trusses, 12 feet
Average width between trusses, 14 feet
Maximum width between trusses, 18 feet

In the hanging of traveling rings from these trusses a 3-inch pipe should be attached to the under side of the lower cords. The pipes should not be joined or coupled together unless there is a hanger on both sides of the coupling. The best method is to use pipe collars made by the leading apparatus manufacturers and bring ends of pipe together under center of cross beams with a collar supporting one end of each pipe. In frame construction it is cheaper to suspend a beam 8 feet from the side wall *and parallel to it*. This beam should be fastened securely between the crossbeams or trusses and flush with the bottom of them.

Windows, Radiators, and Wall Fixtures. — All windows, radiators, and wall fixtures should be located from the standpoint of the use of the side walls for the attachment of various pieces of apparatus and various games. At least a portion of one side should be kept



Mr. A. F. Hussander, Architect.

FIG. 197. — CARTER H. HARRISON TECHNICAL HIGH SCHOOL, CHICAGO, ILLINOIS.

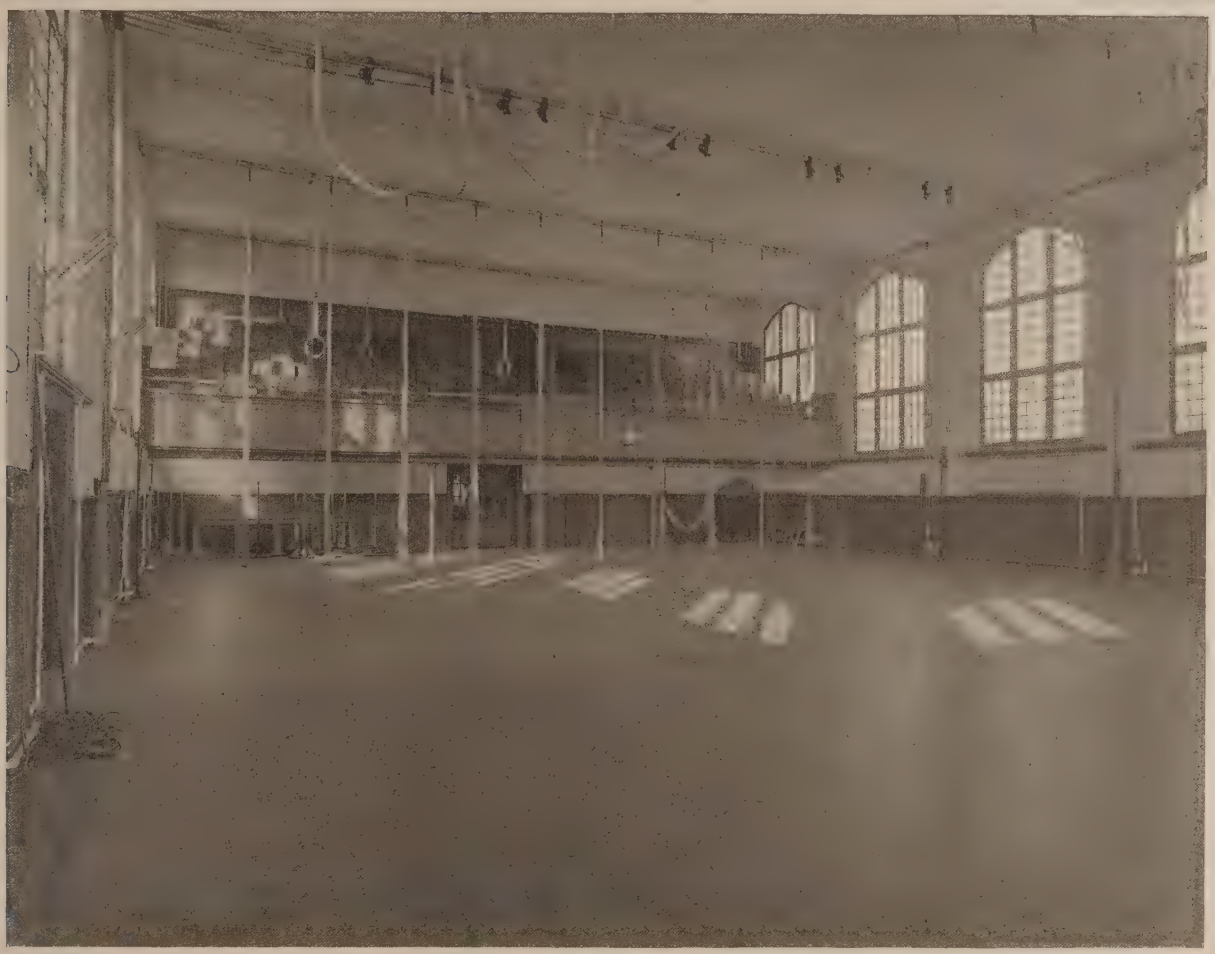


FIG. 198. — GYMNASIUM, JUNIOR HIGH SCHOOL, TRENTON, NEW JERSEY.

free for handball and tennis serving. All windows should be screened and at least eight feet from the floor. The radiators should be screened and should be recessed in the walls with the covering screen flush with the wall. A portion of one end or side should be equipped with a large plate glass mirror in order that the class may observe postural defects.

Lighting, Heating, Ventilation. — Large windows should be provided for light and ventilation. The patent window which opens out is the best type, as this permits the opening up of the whole side of the room. Skylights have not proven satisfactory, as the heat at certain times of the year is too intense. All lighting fixtures should be well protected.

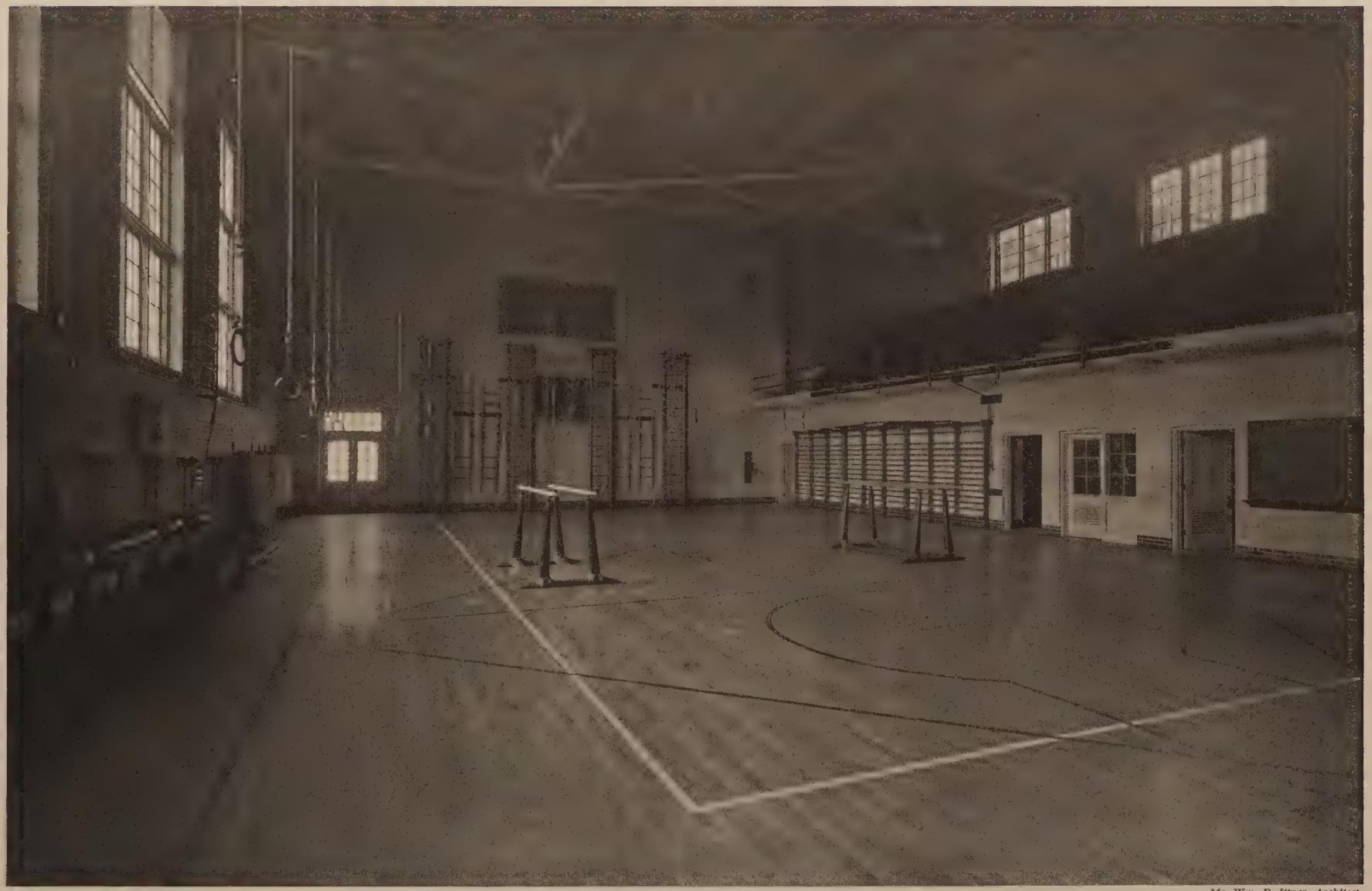
Floor. — Maple is preferred for flooring. There should be a rough under floor $1\frac{1}{2}$ inches in thickness and a finished floor $\frac{13}{16}$ inch or $1\frac{1}{8}$ inches in thickness. In case the light flooring is used it will be necessary to reënforce the floor at points where flush plates are used to hold guys of horizontal bars, etc. This can be done by inserting metal plates or wood strips under the apparatus plates when installing the equipment. Manufacturers will furnish instructions for doing this properly when plans and full particulars are given them.

Marking of the Floor. — Gymnasium floor should be marked for basket ball, indoor baseball, volley ball, handball, and if possible tennis. This marking is more satisfactory if different colors are used for the various courts. Figure 199 of this chapter and figure 2 in chapter 1 contain suggestions in regard to floor marking.

Gymnasium Apparatus. — Only such apparatus should be selected as will be used and adapt itself to class work.

Selections may be had from the following:

Boys' Gymnasium
- 6 chest machines.
- 24 section bar stalls.
- 24 bar stall benches.
- 2 vaulting horses.
- 2 vaulting bucks.
- 2 parallel bars.
- 2 horizontal and vaulting bars.
- 2 suspended horizontal bars.
- 2 horizontal ladders.

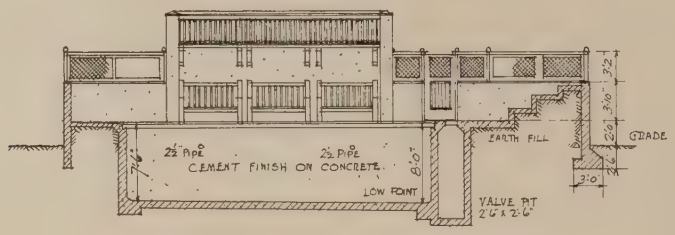


Mr. Wm. B. Ittner, Architect.

FIG. 199. — EDWARD LEE MCLEAN HIGH SCHOOL, GREENFIELD, OHIO.

FIG. 200. — CARTER H. HARRISON TECHNICAL HIGH SCHOOL, CHICAGO, ILLINOIS.

Mr. A. F. Hussander, Architect.



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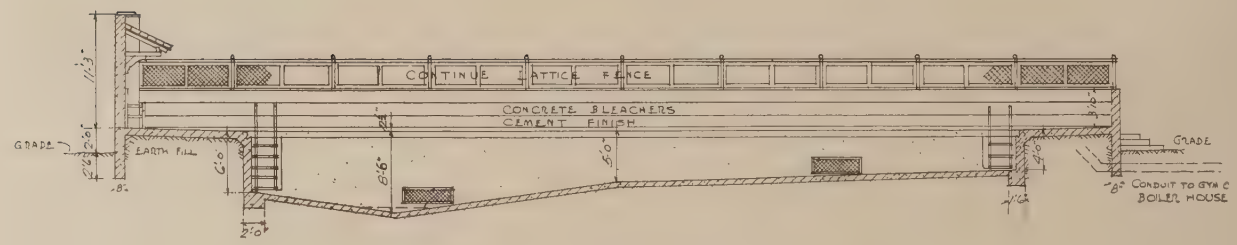

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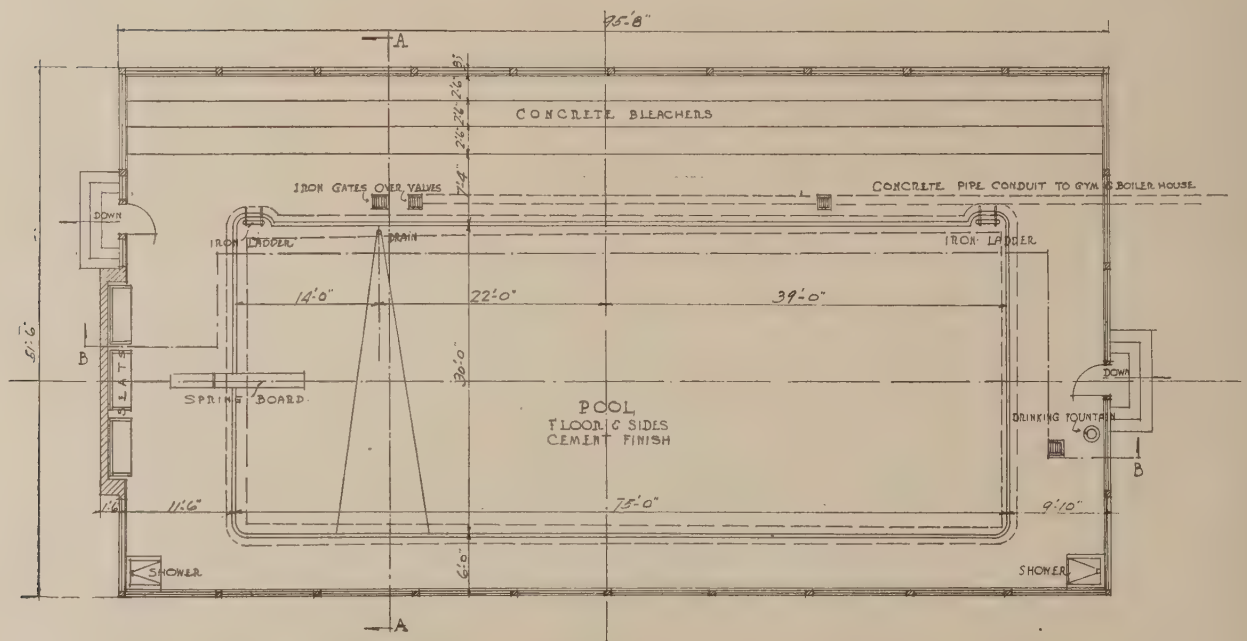

· P L A N ·

· OUTDOOR SWIMMING POOL ·

0 5' 10' 15'

SCALE

FIG. 201.

FIG. 202. — PHOTOGRAPH, OUTDOOR GYMNASIUM.

Boys' Gymnasium — *Continued.*
- 2 to 4 pairs flying rings.
- 6 traveling rings.
- 1 incline board.
- 6 to 12 climbing ropes.
- 3 to 6 rope ladders.
- 1 pair jumping standards.
- 1 spring board.
- 1 vaulting standard.
- 1 pole vaulting board.
- 4 jump boards.
- 10 mattresses of various sizes.
- 1 or 2 pairs basket ball backstops and goals.

Girls' Gymnasium.
- 1 boom.
- 24 section bar stalls.
- 2 bar saddles.
- 24 bar stall benches.
- 2 vaulting horses.
- 1 vaulting box.
- 4 jump boards.
- 6 traveling rings.
- 6 balance beams.
- 1 pair jumping standards.
- 1 incline board.
- 1 spring board.
- 6 to 12 climbing ropes.
- 1 adjustable ladder.
- 1 vertical window ladder.
- 1 horizontal window ladder.
- 3 to 6 rope ladders.
- 1 or 2 sets basketball goals.
- 2 pairs flying rings.
- mats
- miscellaneous small apparatus.

Combined Boys' and Girls' Gymnasium.
- 6 chest weights.
- 24 sections bar stalls.
- 24 bar stall benches.
- 2 vaulting horses.
- 2 vaulting bucks.
- 2 parallel bars.
- 2 horizontal and vaulting bars.
- 1 or 2 swinging booms.
- 1 adjustable ladder.
- 3 to 6 rope ladders.
- 6 to 12 climbing ropes.
- 2 pairs flying rings.
- 6 traveling rings.
- 1 pair jump standards.

Combined Boys' and Girls' Gymnasium — *Continued.*

1 spring board.
1 inclined board.
mattresses.
4 jump boards.
1 or 2 pairs basket ball goals.
calisthenic apparatus.

Information and advice regarding the equipment of gymnasiums may be obtained gratis from the apparatus manufacturers if the necessary information is given them.

Room for Corrective Gymnastics. — A special corrective room may be arranged over the office and shower rooms. In this room should be placed an abdominal stool, plinth, stall bar, single wall parallel bars, two tables, and two bar stalls.

Game Room. — A special room should also be provided for the boys for boxing, wrestling, fencing

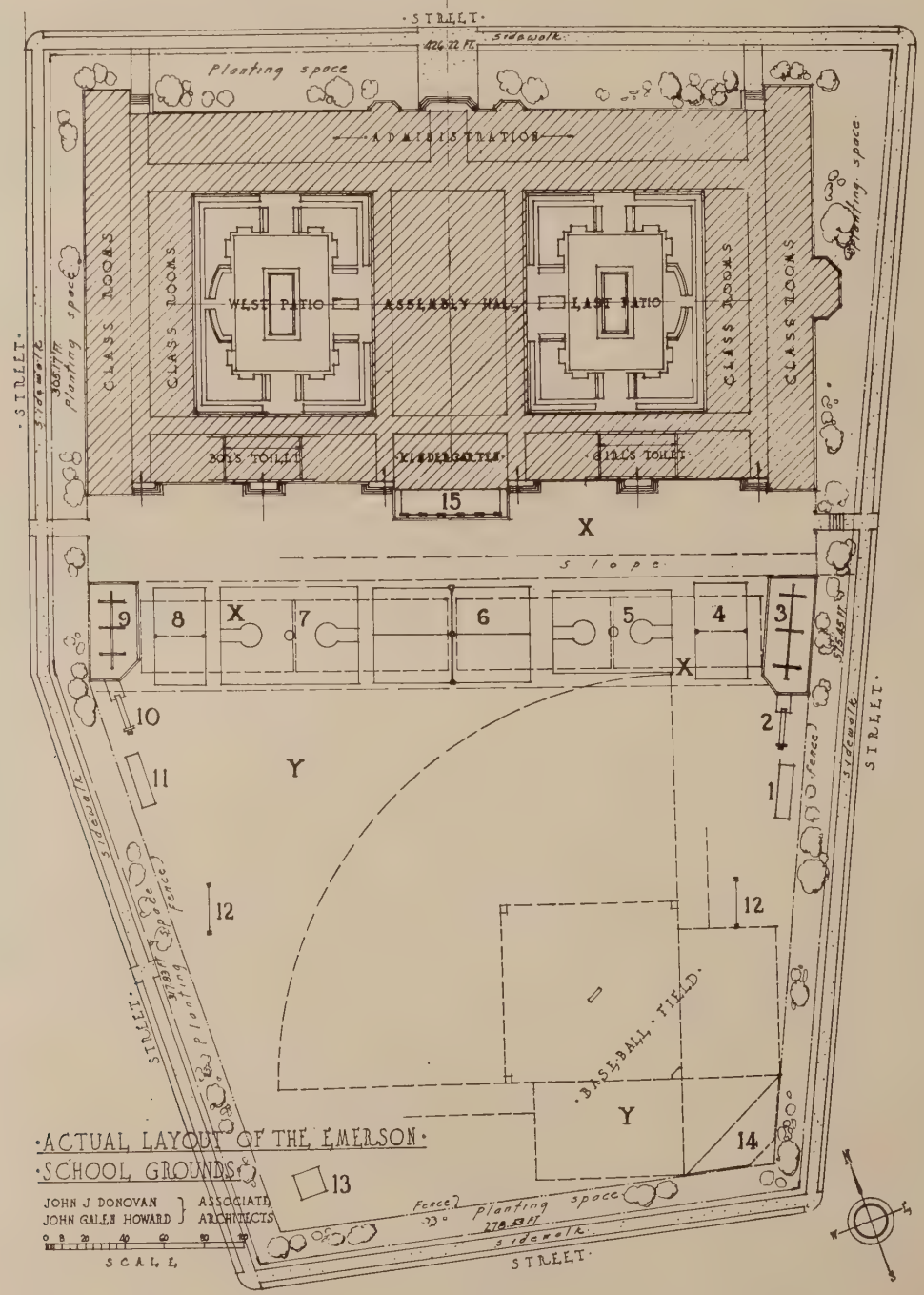

FIG. 203.

FIG. 204. — PHOTO OF SANDBOX, SLIDE AND GYMNASIUM FRAME.

punching the bag, etc. A handball court might be planned.

Swimming-Pools. — Swimming as an activity in connection with our schools has a very important place in physical education, and complete swimming facilities should be provided at least by all intermediate and high schools.

Indoor Pool. Size. — A narrow pool is desirable, as the side of the pool may be much more easily reached by persons who are just learning to swim. Wherever possible, an outdoor pool should be used, but if an indoor pool is used, the matter of ventilation should be carefully considered. A skylight would be an advantage. At least plenty of windows should be provided, so that the place could be flooded with the direct rays of the sun. See figure No. 200.

The following sizes are suggested for school conditions:

20×40, minimum size
25×75, maximum size

Other Dimensions. — The depth at the shallow part of the pool should be 3 feet and at the deepest point 8 feet, 6 inches. See figure 201. The deepest point of the pool should be ten to twelve feet from the deep end, thus the pool will slope both ways to this point. The sides of the pool should be clearly marked to show depth of the water. An overflow drain should be provided. It is sometimes combined with a hand rail and "spit gutter" around the entire pool. Water should be kept constantly flowing over this rail. Ten per cent to fifteen per cent of the contents of this pool should flow over the rail each day.

When designing the drainage, the disposal of the water when emptying the pool should be carefully planned. Unless this is observed the house drains and plumbing fixtures will be flooded. Where possible, the water should be used for the irrigation of the lawns and gardens.

Problems in Connection with the Sanitary Condition of the Water. — To be exact, water in which people swim should be as pure as the water which they drink. This, however, is seldom the case. The main problems in connection with pure water are as follows:

(1) Secure pure water to begin with. In other words, see that the source of the water is pure.

(2) See that persons who use the pool cleanse themselves thoroughly before entering the pool. This does not mean having an entire class run through a shower, but means the application of warm water and soap.

(3) See that the suits are clean. Bathing suits should be thoroughly cleaned after being used. Care should be taken that swimming suits are dyed with fast dyes.

(4) Treatment of water after having been used.

(*a*) Filtration. — The most common method of treating the water is by a well-constructed filtration plant, and from experience it will probably be given first preference.

(*b*) Ultra-Violet Ray System. — The ultra-violet ray system when installed by a reliable firm does excellent work.

(*c*) Chemicals. — A number of chemicals are used for purifying the water:

Fig. 205. — Kindergarten Porch, Emerson School, Oakland, California. *Mr. John J. Donovan, Architect.*

Copper sulphate
Anhydrous chloride
Chloride of lime

Of these three, chloride of lime is recommended as being the easiest to handle and the most efficient. One-tenth pound to 5000 gallons of water is recommended as a dosage every 3 or 4 days. The water should be examined frequently.

(5) Heating. Figure 201 shows means of heating pool.

Outdoor Pool. — The open air pool is preferred where conditions warrant. Figure 201 gives a number of suggestions in this line.

Outdoor Semi-Outdoor Gymnasium. — As was suggested under Indoor Gymnasium, the matter of providing the gymnasium with adequate fresh air is a big problem. In all places where weather will permit and in all climates when the weather is mild all of the gymnastic work should be conducted in the open air. See figure 203. There are a number of elements which make this difficult, and they vary in different climates. The winter season in certain states will be the biggest obstacle. Casual rain, severe wind, and the hot suns are also heavy impediments. A semi-outdoor gymnasium could be provided with a roof and with side walls open above 12 feet. Thus in good weather the exercise can be taken practically in the open, and during inclement weather protection may be had.

Play Yard (Outdoor Exercise Floor). — The school play yard should be considered a large exercise floor for a number of reasons:

(1) It should be equipped for all physical training activities.

(2) It should be equipped as a community playground for the recreation of the adult and the play activities of the children. As such it should be open after school hours, Saturdays, Sundays, holidays, and vacations.

Old Idea of Equipment of Play Yard. — The old idea of equipping a play yard was that there should be a large amount of equipment on a relatively small piece of ground, and the children would come there and amuse themselves. Thus there were a great many swings, slides, teeters, teeter ladders, giant strides, merry-go-rounds, apparatus to climb on, etc.

Fig. 206. — Wire Cage Baseball Back-Stop.

New Idea of Equipment of Play Yard. — The new idea of equipment of play yards is that there shall be a relatively large piece of ground with a few standard pieces of equipment. Large areas shall be left for running and team games, such as hockey, soccer, baseball, basket ball, etc. It is in these games that great social values are derived, and these can never be derived from the individual play of the old type of playground.

Field House. — With school buildings that are not equipped for this modern idea a field house will have to be provided, in which will be located showers, dressing rooms, toilets, and an office.

Size of Play Yard. — The elementary school play yard should vary between 3 and 7 acres, according to the size of the school. Efficient work for large numbers cannot be done on a yard with smaller space than this.

The intermediate school play yard should cover from 10 to 15 acres, as the needs of the older boys and girls will be considerably greater than they are in the elementary grades.

The high school playground should cover from 15 to 25 acres, with complete facilities for the handling of all types of high school and adult activities.

Plan and Equipment of Play Yard. — The pieces of apparatus should be arranged around the sides of the ground, thus leaving all of the central part of the ground for athletic games. On small elementary school grounds the girls' and small children's apparatus should be placed on the side of the ground near the school building, and the boys' on the space furthest from the school building. This arrangement tends to give the girls and small children protection from the balls in the heavier athletic games and it also protects the windows in the school building. Baseball fields and courts especially should be arranged at the furthest point from the school building, where possible in the northeast corner of the grounds. The next choice should be the northwest corner, the southwest and southeast following in turn. Football fields, tennis courts, basket ball courts, volley ball courts, where possible, should be laid out north and south, in order to protect the players from the direct rays of the sun. Activities should be conducted in a safe place.

Elementary School. — Plan No. 1. The Emerson School, Oakland, Calif. (Figure 203) is a small, well-balanced yard. Description of apparatus indicated by numbers in figure 203 is as follows:

No. 1. Girls' Sand Box. The dimensions of this are 1×5×12 feet. It is equipped with a shelf around the top, which serves either as a seat or a molding table.

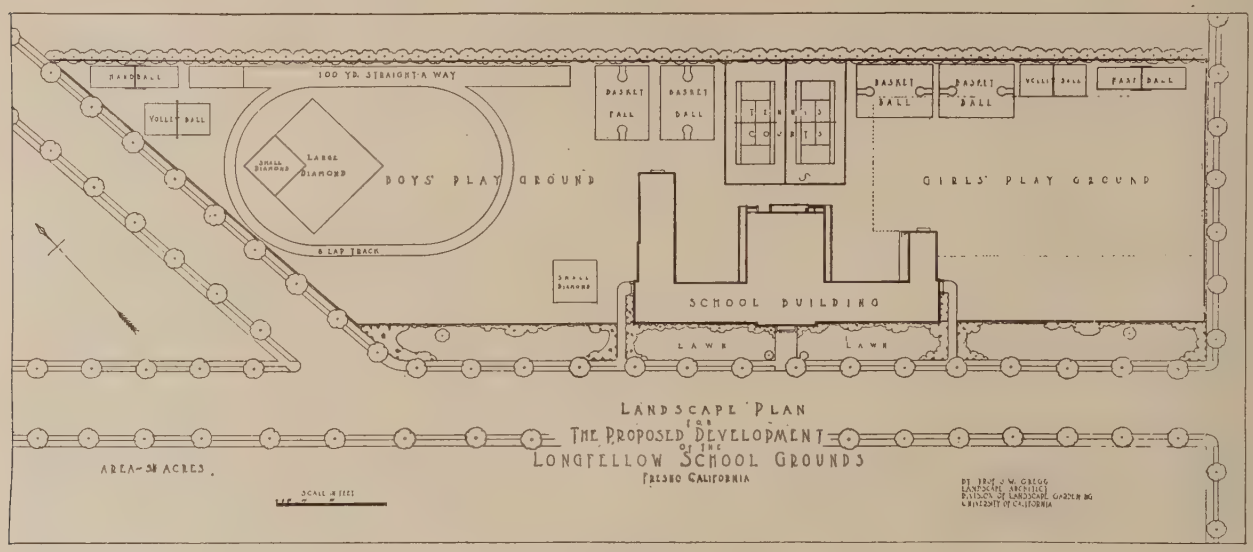

FIG. 207.

It is filled with a coarse grade of sand, which will not become dusty in dry weather or muddy when moistened.

See figure 204.

No. 2. Girls' Slide. This is a medium-sized slide and equipped with a landing pit filled with clean sand.

For a substitute — Horizontal Ladder (Girls). This should be purchased or well constructed. Rails, $1\frac{3}{4}''$ oval made from $2''\times6''$ — 14′ long, 16″ apart; rundles of hard wood $1\frac{1}{4}''$ diameter. Set 6′ 6″ from ground well supported.

No. 3. Girls' Gymnasium Frame, which consists of a set of six traveling rings. This particular unit has been found most satisfactory for girls.

No. 4. Girls' Volley Ball Court, which has 4×4 inch posts set in sockets, so that they may be easily moved.

No. 5. Girls' Basket Ball Court — posts set in sockets. (Numbers 4 and 5 are convertible into tennis courts during seasons when basket ball is not played.)

No. 6. Double Handball Courts. One side for boys and the other for girls. This consists of plain handball backstops twenty feet wide, twelve feet high, with a six-foot wire extension. See figure 205.

No. 7. Boys' Basket Ball Court — posts set in sockets.

No. 8. Boys' Volley Ball Court — posts set in sockets. (Number 7 and 8 are convertible into tennis courts.)

No. 9. Boys' Gymnasium Frame. Unit selected for boys' gymnasium frame is one horizontal bar, one climbing pole, one climbing ladder, two sets flying rings.

Substitute: Horizontal Bar (Boys'). Hickory or steel bars can be purchased. A 1″×6′ galvanized iron gas pipe will do. Set in two posts so that the bar will be rigid.

A high bar 6′ 6″ and a low bar 5′ should be constructed. An adjustable bar with holes in 6″×6″ posts from 2′ to 5′ is not difficult to make and is very valuable.

No. 10. High Slide for Boys, equipped with landing-pit filled with sand.

No. 11. Sand Box for Boys, equipped as number 1.

No. 12. Soccer Posts, made of 6×6 inch posts. Size of field is reduced to 50×80 yards, which has proved satisfactory for school playground purposes. Hockey is played on this field.

High Jumping Pit, filled with shavings.

Wire Cage Backstop for baseball. See figure 206.

Hockey Field (played on soccer field) size 150′×225′ (smaller size will do). Construction: *a.* surface — smooth and level. *b.* Goals — 4″×6″ uprights 7′ (4″×4″ will do) above the ground 12′ apart with a 2″×4″ crossbar. If posts are not available, mark the distance with two stones or other objects.

No. 13. Open Pergola Porch, covered with canvas in the summer time, which affords a place for small children to hold club meetings and enjoy diversified play. See figure 205.

Surface marked X is an oil macadam composition. It makes an excellent surface for court games.

Surface marked Y is covered with crushed rock dust. It makes a good baseball field, but is a little too hard for football, for which sandy loam would be better.

Plan No. 2 — figure 207.

This is a better arrangement than in figure 203, as more open space is left for the girls' large games. Also tennis courts are provided.

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FIG. 208. — BUSHROD PLAYGROUND, NEAR WASHINGTON SCHOOL, OAKLAND, CALIFORNIA.

FIG. 209. — MOSSWOOD PARK, TENNIS COURTS, OAKLAND, CALIFORNIA.

FIG. 210. — TRACK, BUSHROD PLAYGROUND, OAKLAND, CALIFORNIA.

Figure 208 shows a playground for elementary boys and girls with a small field house adjacent. The division of the ground for boys and girls will be noted. The swings are fenced, courts well marked. The gymnasium frame has a layer of 12″ to 14″ of shavings under it.

Intermediate School. — As the games for the intermediate school are more vigorously played than those of the elementary school, greater allowance should be made for areas between play courts. Therefore the intermediate school requires the following additional equipment:

FIG. 211. — HOCKEY FIELD, MOSSWOOD PARK, OAKLAND, CALIFORNIA.

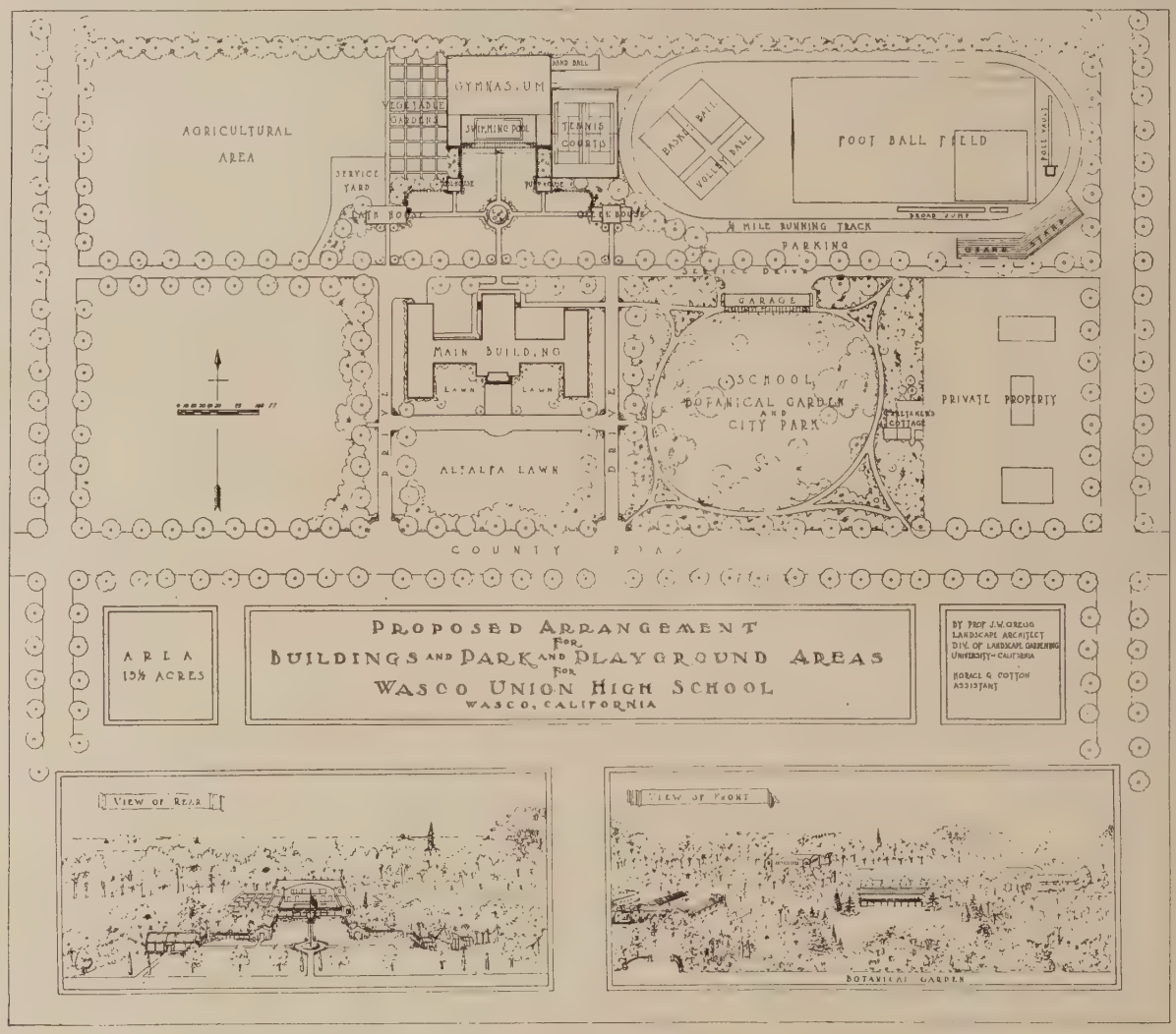


FIG. 212.

Boys' Field.

2 tennis courts. See Fig. 209.
2 handball courts.
¼ mile running track (football and baseball fields in the oval). Fig. 210.
1 soccer field (150′×240′).
2 basket ball courts.

Girls' Field.

2 tennis courts.
4 indoor baseball diamonds — 45′ base line.
1 hockey field and general play area. Fig. 211.
2 volley ball courts.

High School. — In addition to the equipment of the elementary school playground, the high school should have the following:

Boys' Yard.

3 tennis courts.
2 handball courts.
¼ mile running track (football and baseball fields to be placed in the oval).
2 basket ball courts.
1 soccer field.
1 canvas golf driving net and green.

Girls' Yard.

3 tennis courts.
4 indoor baseball diamonds — 45 ft. bases.
2 hockey fields.
4 volley ball courts.
1 canvas golf driving net and green.

Figure 212 shows a fine arrangement for a large intermediate school or a small high school. The part marked "Agricultural Area" should be the girls' athletic field, and the part of ground just in front should be used for the agricultural area.

This ground occupies 15½ acres. Many new high schools are acquiring as high as 30 acres for a school site. This allows ample space for a thoroughgoing program of Physical Education for the entire student body of a large school when properly organized.

CHAPTER XI

THE ADMINISTRATIVE OFFICES IN PUBLIC SCHOOL BUILDINGS

By William F. Ewing, M.A., *Principal, Pasadena High School, Pasadena, California*

I. Small Elementary School. (1) Principal's Office. (2) Teachers' Room. (3) Janitor's Quarters. (4) Playground Supervisor's Office. II. Large Elementary School. (1) General Plan. (2) Principal's Office. (3) Teachers' Rest Room. (4) Girls' Rest Room. (5) Library. (6) Janitor's Office. (7) Playground Supervisor's Office. (8) Teachers' Lunch Room. III. Medium-sized High School or a Junior High School. (1) General Plan. (2) General Office. (3) Principal's Office. (4) Men Teachers' Room. (5) Women Teachers' Room. (6) Girls' Rest Room. IV. Administrative Offices in a Large High School. (1) General Plan. (2) Registrar's Office. (3) Principal's Office. (4) Office of Dean of Girls. (5) Office of Dean of Boys. (6) Office of Continuation School Principal. (7) Attendance Office. (8) Offices for Heads of Departments.

Administrative Offices in Public School Buildings. — In responding to the growing demands of modern social life, our schools have become highly organized institutions. In the planning and construction of large up-to-date school buildings we ought to make a scientific study of the size and orientation of grounds, of the proper arrangement of classrooms, offices, and other parts of the plant. We should be able to assist the school architect in securing good lighting, satisfactory ventilating and heating and proper sanitary arrangements. We ought to know the kind and quality of equipment to be installed.

The proper development of the child is the most important thing in education. This thought should be the guiding principle for boards of education, superintendents, principals, teachers, and others interested in promoting and extending the ideals of American education. A generation ago we limited our school activities almost exclusively to academic studies. Now the school has become the center of the child's world; not merely an intellectual one, but a real, physical, and social world.

Our public schools are co-educational. Pupils are living as truly in their educational life at school as they ever will after school days are over. Communities spend thousands of dollars for a single school building. We want the best for our children. However, one of the most important features in the planning of school buildings seems almost wholly neglected. That is the administrative quarters. The reason for this is that school administrators have failed to study the problem, leaving it to the architect to assign such areas as would best fit into the general plan. The result has been poorly arranged and inadequate quarters.

Many years' experience in private and public schools convinces the writer that the enrollment of the school and size of plant are both increasing. In rural communities, consolidation of numerous small districts into larger, more modern organizations is growing. In cities we are coming to look upon schools of five hundred to one thousand children as quite ordinary. In the cosmopolitan centers there are individual schools having enrollments varying from one thousand to three thousand pupils. As our schools increase in size, the more complex become the administrative problems. The larger school buildings indicate a tendency toward the centralization of the administrative offices.

For convenience it has seemed best to divide this discussion into four parts:

I. Administrative offices in a small elementary school.

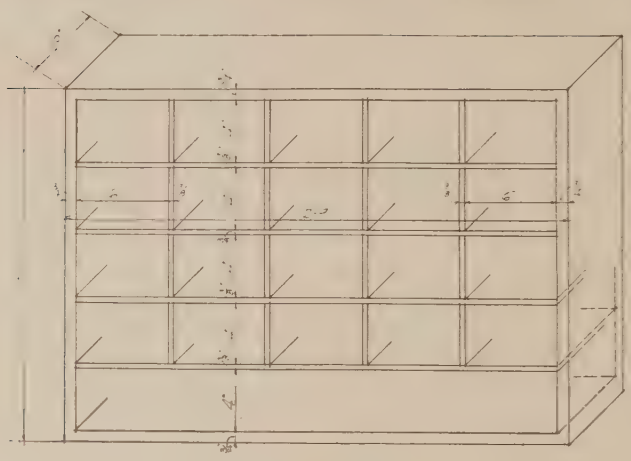
II. Administrative offices in a large elementary school.

III. Administrative offices in a medium-sized or junior high school.

IV. Administrative offices in a large high school.

Administrative Offices in a Small Elementary School. — Assuming that the small elementary school has an enrollment of from one hundred and twenty to three hundred children, and estimating an average of thirty pupils per teacher, we shall have from four teachers to ten teachers in the school. The need for careful planning will obviously increase with the size of the school. A study of the literature on school architecture shows that much has been written on grounds and little on the planning of school buildings.

The following plan is suggested for small elementary schools. (See figure 214.)



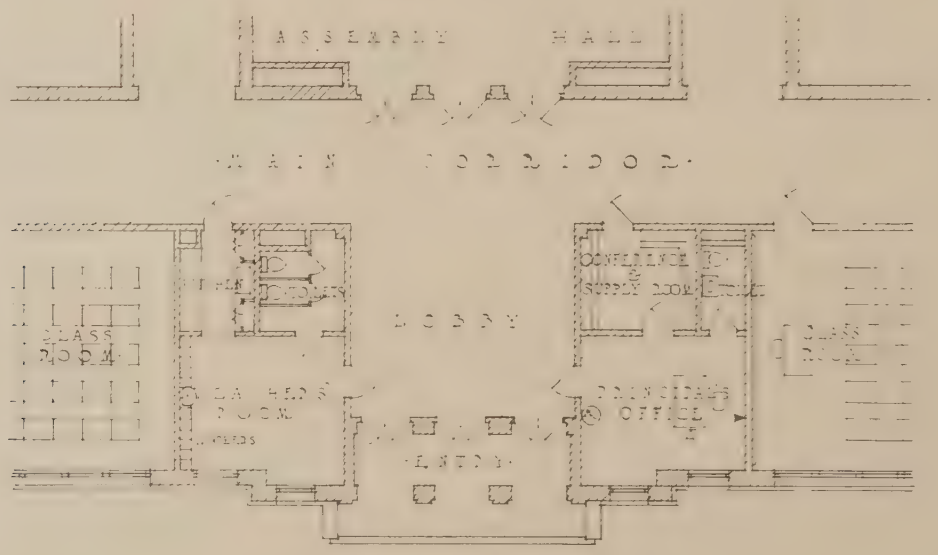
· FRONT VIEW ·
TEACHERS' POST OFFICE & EXCHANGE BOX ·
MATERIAL QUARTER SAWED OAK

FIG. 213.

1. Principal's office.
2. Teachers' room.
3. Janitor's office.
4. Office for the playground supervisor.

The Principal's Office. — In most public school buildings the principal's office is located on the first floor near the main entrance. Unfortunately for administration, it is most frequently located facing the street and not the playground. It should be well lighted and large enough to carry on the work of administration without crowding. Since necessity often requires the principal to work in her office after full hours and on days when school is not in session, there should be some means of heating the office independently of the general plant. The floor of the office and all other administrative offices should be covered with battleship linoleum. A good Wilton rug will add to the comfort and attractiveness of the room. A fine quality of scrim curtains may be hung at the windows.

The interior finish should be quarter-sawed, antique oak. The furniture should be of the same kind and finish as the interior. Since the needs of the school are constantly changing, portable filing cabinets and sectional bookcases are desirable. These are well made and being constructed in units can be increased or decreased according to demand. A teachers' exchange cabinet, containing compartments for all the teachers, the janitor and supervisor, should be attached to the wall near the entrance to the office. At the bottom of the cabinet there should be an extra long division for large books, maps, etc. (For dimensions of the cabinet, see figure 213.)



PLAN OF PRINCIPAL'S AND TEACHERS' SUITE FOR A SMALL ELEMENTARY SCHOOL

0 5' 0 5

SCALE

(C) MASTER CLOCK
(D) SECONDARY CLOCK
PUBLIC TELEPHONE
PRIVATE INTERCOMMUNICATING PHONE

FIG. 214.

If there is sufficient wall space on either side of the exchange cabinet, one or more bulletin boards should be installed. A bulletin board should be at least two feet by four feet in size. It should be faced with a layer of cork. A beveled edge, plate glass top for the desk will prove a great convenience, for under it school and health regulations, telephone numbers, programs and other items of information most frequently used can be neatly and carefully kept. A few good pictures should be selected for the walls of the room.

A door opening from the principal's office into a classroom is an advantage, for it provides a means to keep some one in touch with the telephone and office when the principal is engaged in supervision elsewhere. Adjacent to the office there should be a conference and supply room. It should be fitted with ample cabinets for keeping books and supplies that are needed frequently. It is a good plan to have cabinets closed with glass doors that can be locked. The conference room should have a door opening into the corridor. This would afford easy access for the janitor to deliver supplies, and it would serve also as an exit for callers.

The school telephone exchange, master clock, and public telephone are invariably placed in the principal's office. Provision should be made for a lavatory and toilet directly off the office.

The principal's room should be made as attractive as possible, not merely for the satisfaction of the principal herself, but for the wholesome effect it will have on teachers, pupils, and patrons.

The Teachers' Room. — Every school building should provide convenient quarters for the teachers when they are not on duty. The size of the room will depend upon the number of teachers employed in the school building. The interior finish, curtains, kind and quality of furniture should correspond to that of the principal's office. The room might serve as a rest room and dining-room combined. It ought to be furnished with a couch, pillows and blankets, and a " first-aid " outfit.

Adjacent to the teachers' room there should be a set of toilets and a lavatory. Opening into the room there should be a small kitchen equipped with a gas stove, sink, china closet, and such cooking utensils as are necessary for preparing simple meals. There should be an exit from the kitchen direct to the corridor. In some schools full-sized steel lockers are placed in or near the teachers' room for use of the teachers.

The Janitor's Quarters. — A casual examination of the plans of scores of the best, up-to-date school buildings discloses the fact that almost always the janitor's quarters are located in the basement of the building. Frequently they are put in a dark, poorly ventilated place near the furnace. If the janitor has an office, it is often a portion of the furnace room. Such conditions should no longer obtain. The janitor ought to have a comfortable office, well lighted, properly ventilated and heated. It should be equipped with a washstand having both hot and cold water connections. In addition there should be a full-sized steel locker. If possible, the office should face the school playground.

In the primary school the janitor is usually the only male employee. His influence among the boys often counts for more than that of the teacher. If he is kind and sympathetic, he may also claim the friendship of the girls. The wise and loyal janitor can easily prevent many cases of petty discipline from reaching the principal.

Adjacent to or near the janitor's office, there should be a storage and work room. Tools and school supplies needed only occasionally may be kept there. A good work bench should be provided for the room.

An Office for the Playground Supervisor. — Many cities have established municipal playgrounds in connection with the schools. These playgrounds are open after school hours until five P.M. or later, according to the season of the year. They are in charge of a playground supervisor, who may be a teacher in the school or a regular municipal playground employee. If a school is planned for after school activities, it is desirable to have an office for the supervisor.

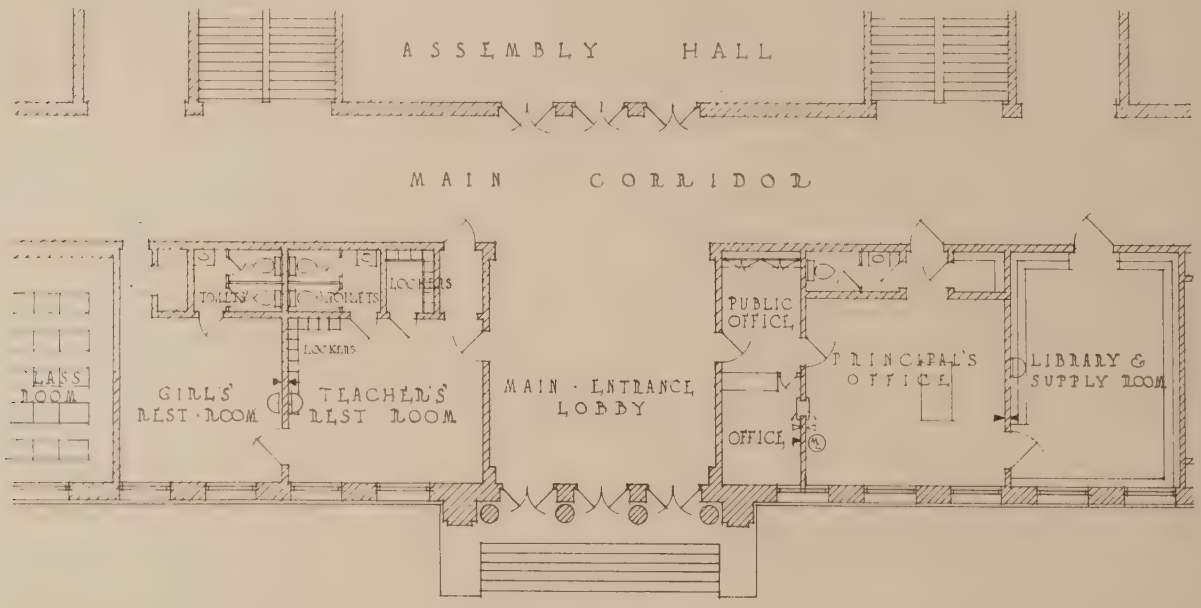
The office should be located in the basement, facing the playground. The interior and furniture should be similar to that of the janitor's office. Since the playground supervisor needs to have easy communication with school officials and homes, the office should be connected with an outside telephone.

It should be furnished with a desk and chairs and a cabinet for keeping supplies such as balls, bats, nets, and mits. In short, the playground supervisor's office ought to be so well furnished that it would be unnecessary to use any part of the regular school equipment.

A portion of the office should be set apart as a dressing room. It should be equipped with a washstand fitted for both hot and cold water, full-sized steel lockers for keeping clothing and other valuables, and with a couch, pillows and blankets, and a "first-aid " outfit.

Administrative Offices in a Large Elementary School. — Practice seems to favor the centralizing of administrative offices in large schools. In many cities, school buildings are constructed on the unit plan, thus providing an easy and satisfactory means for enlarging the plant, but it is usually quite difficult to increase the number and size of the administrative offices, hence it is desirable to plan them in the beginning for the maximum capacity of the school.

Assuming that the large elementary school will have an enrollment of from three hundred to fifteen hundred pupils and estimating an average of thirty pupils to a teacher, we shall have from ten to fifty teachers in the school. The need for ample quarters, therefore, is obvious. The real problem is to determine definitely what rooms should be included in the administrative suite. For our discussion let us include most of those quarters which are not directly under the supervision of the class teachers. We shall then have the following.



PLAN OF PRINCIPAL'S & TEACHERS' SUITE FOR A LARGE ELEMENTARY SCHOOL

FIG. 215.

planned large school buildings we find an outer waiting room. The entrance to it is usually from the vestibule or the main corridor. It is a great convenience to have an outer waiting room where the teachers may register their time on arriving at school in the morning and leaving again in the afternoon. Figure 215 shows a division between the public waiting room or lobby and the secretary's office. The two divisions of this office may well be separated by means of a large, wide counter, at one end of which is a gate providing an entrance to the secretary's desk. The inside of the counter should be fitted with shelves and pigeonholes for keeping blank forms and office supplies. There should be an easy entrance from the secretary's office to the principal's.

General Plan. (See figure 215.)

1. A principal's office. (See figure 216.)
2. A teachers' rest room.
3. A girls' rest room.
4. A library.
5. A janitor's office.
6. An office for the playground supervisor.
7. A teachers' lunch room.

The Principal's Office. — In the large elementary school the principal's office should be spacious enough to accommodate several persons at the same time. Frequently the principal wishes to call meetings of various groups of pupils or teachers or both; these can be held in the principal's office better than elsewhere, if there is ample room.

The fixtures, floor covering, filing cabinets, and bookcases should be of the same kind and quality as those n the small elementary school. In any of the best-

This plan shows both lavatory and toilet directly in the rear of the principal's private office. An exit from the latter office is desirable. It is often embarrassing to dismiss parents or teachers into the public waiting room.

The Teachers' Rest Room. — In order that the principal may have an easy means of supervising the teachers' room, it seems advisable to have it located near the main office. General practice indicates this, although in some well-arranged buildings the teachers' rest room is located on the second floor rather than opposite the principal's office on the first floor. The location of the room will be determined by the con-

FIG. 216. — PRINCIPAL'S OFFICE, CLAWSON SCHOOL, OAKLAND, CALIFORNIA. *Mr. John J. Donovan, Architect.*

venience it offers the teachers. Figure 215 shows a rest room opening from the main entrance and having an exit to the main corridor as well as to the girls' rest room. The teachers' rest room should be fitted with suitable chairs, couches, blankets, pillows, and other comforts. Adjacent to the room or opening into it there should be a locker room, a set of toilets, and a lavatory.

The Girls' Rest Room. — The girls' rest room should be provided with toilets, a lavatory, and a supply room. The rest room should be furnished with a table and chairs, couches, pillows and blankets, and a "first aid" outfit. For convenience there ought to be an exit to the main corridor. One of the main reasons for placing the girls' rest room adjacent to the teachers' is that the teachers should have pretty close supervision over the girls wherever they happen to be.

The Library. — The up-to-date, large elementary school should have a room set apart for a library. It should be fitted with bookcases or cabinets covered with glass doors. The size of the room and the capacity of the cases will depend largely upon the size and character of the school. If it has free text books there should be ample storage for all incoming books and other supplies frequently used. Figure 215 shows entrances to the library both from the principal's office and from the main corridor.

The Janitor's Office. — The usual practice provided an office for the janitor in the basement of the building. If possible it should be so located that there will be easy access to the furnace room, to the playground, and to the boys' toilets. The office should be placed so it will have an abundance of light and good ventilation. It should be equipped with proper furniture and a locker for clothing and other valuables. It should have a washstand fitted with hot and cold water. If possible, adjacent to the janitor's office there should be a work room fitted with a good work bench and adequate tools for doing repair work. In many schools the janitor is the only person who can attend to small repairs when they are most needed. If the school has a garden, it would be well to provide the janitor with garden tools.

An Office for the Playground Supervisor. — If the school has a playground, a good office should be provided for its supervisor. Almost none of the plans of elementary schools show any provision for this activity, although many cities have established playgrounds in connection with the larger elementary schools. The playground office should be well lighted and heated. It should have linoleum floor covering, with perhaps one or two small mats. The office should have a table and chairs and a cabinet for keeping playground supplies. Generally the playground work is in charge of one of the women teachers. It is quite desirable that she should have a place to dress and to keep her personal effects when she is attired in playground costume. A small dressing room containing a couch, blankets, " first aid " outfit, a washstand and locker would prove a great convenience.

The Teachers' Lunch Room. — Since the teachers' lunch room forms a daily meeting place for teachers and principal, it seems best to include it in the administrative offices. Some modern school buildings have provided lunch room and kitchen facilities solely for the use of the teachers, though in many schools the domestic science equipment is used by the teachers for preparing light lunches. The best plan, however, seems to require separate accommodations for teachers and pupils. The location of the lunch room should naturally be determined by the character of the building. If there is a high, well ventilated basement, and room can be found to locate the teachers' lunch room and kitchen on the sunny side of the building, there is no objection to having it placed in the basement. The lunch room should be large enough to accommodate all the teachers and one or two occasional visitors. There should be plenty of chairs and a good table. The lunch room should be as cozy and homelike as possible. Immediately off from the lunch room there should be a kitchen fitted with a gas range, china closet, sink, and such utensils as may be regulated for preparing simple lunches.

Administrative Offices in a Medium-Sized High School or in a Junior High School. — In the past, the planning of administrative quarters in the medium-sized academic high school received more attention than those of other school buildings. An explanation for this condition may be easily found. For many years the city high school was a medium-sized organization. It was the pride of the city. High school principals and high school teachers learned the administrative needs of the school by years of experience. Furthermore, the high school faculty was composed of a comparatively small group of men and women. They were well acquainted with each other. They were known by their pupils. The principal could issue orders by " word of mouth," and he could personally supervise the work of each teacher and of every class.

All these conditions obtained in the older academic type of school. But with the expansion of our high school curriculum and the inclusion of many formerly so-called extra-curricular studies, we are forced to pay more attention to the planning of the school and the administrative offices.

Figure 217 embodies some of the best ideas for the medium-sized high school.

General Plan.

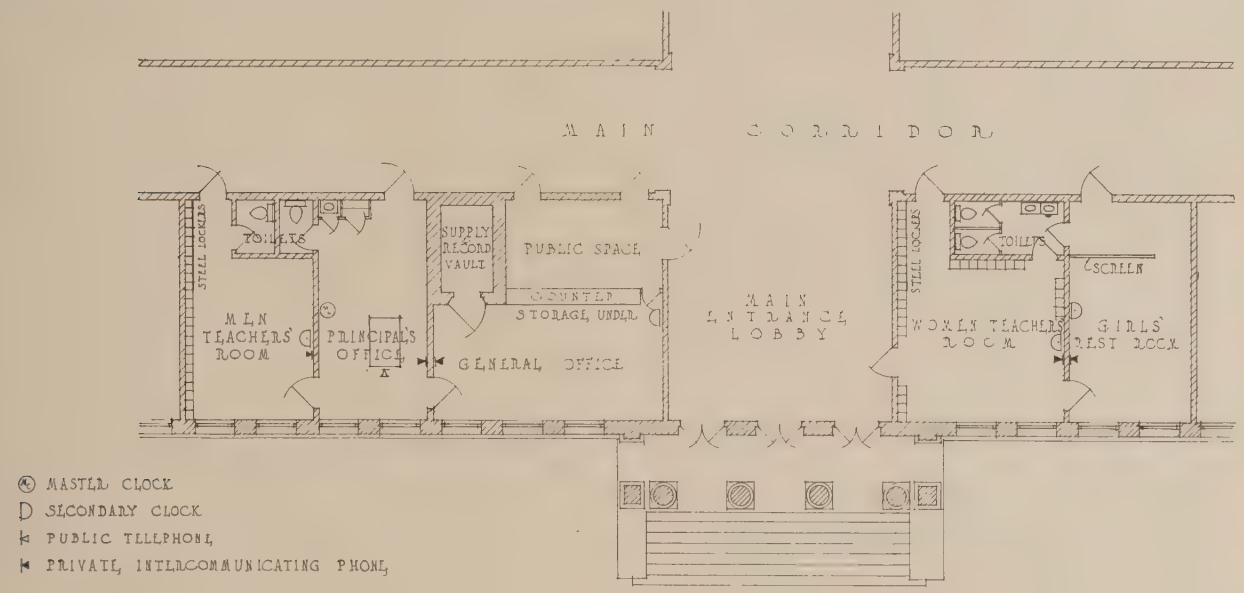
1. A general office.
2. A principal's office.
3. A room for men teachers.
4. A room for women teachers.
5. A girls' rest room.

The General Office. — In the medium-sized high school we frequently find that there is an outer office or waiting room adjacent to the principal's office. This seems to be a desirable plan, for many of the questions that come to the principal's office can be answered without interrupting the constructive work of the principal. Figure 217 shows a large general office near the main entrance. Entering the general office is a waiting room or public space. It is separated from the general office by a large, high counter at one end of which is a gate. The rear of the counter should be fitted with pigeonholes and shelves for keeping office appliances, blanks, stationery, and other equipment. On top of the counter under a heavy glass plate there may be kept the school program and such other frequently used bulletins of information. The waiting room has a door to the main corridor and one to the main entrance. The general office should be equipped with the usual filing cabinets, bookcases, desks, and chairs. The public telephone, the master clock, and the school telephone exchange should be installed in the general office. Opening into the office is a door to the vault and record room. At one side of the office is a door to the principal's office.

The Principal's Office. — The principal's office is located between the general office and the men teachers' room. There is a passage to both the general office and the men teachers' room from the principal's office, also an entrance from the main corridor to the principal's office. There is a lavatory and toilet opening off the principal's office, also a small cloak room. The furniture and equipment of the principal's office will be of good quality, quarter-sawed antique oak. The floor should be covered with plain, battleship linoleum. It will add to the attractiveness greatly, if it is covered with a good Wilton rug.

The Men Teachers' Room. — The men teachers' room should be furnished with a table and chairs and provided with enough steel lockers so that each teacher would have a full-sized locker. Opening off from the room should be a toilet and lavatory.

The Women Teachers' Room. — Across the lobby from the general office should be the women teachers' room. The floor should be covered with a good quality of linoleum. It should be furnished with chairs, a table, and a couch. On one side of the room there should be a number of steel lockers, at least one for each teacher.



PLAN OF PRINCIPAL'S & TEACHERS' SUITE FOR A MEDIUM SIZED HIGH SCHOOL.

0 5' 10' 15'

SCALE.

FIG. 217.

The furnishings for this room should be left to the judgment of the women teachers. It should be made as cozy and comfortable as possible. Opening off the room there should be a set of toilets and lavatories. At one side of the room there is a door into the girls' rest room.

The Girls' Rest Room. — The girls' rest room should be furnished with chairs, couches, blankets, pillows, and a "first-aid" outfit. In order to give as much privacy as possible it is desirable to have a screen between the entrance to the room and the main part of it.

Administrative Offices in a Large High School. — A study of the plans of many large high school buildings of recent construction shows that there has been little attempt to centralize the administrative quarters. The usual plan indicates a suite of offices located on the first floor near the main entrance to the building. The suite consists of three or four adjacent offices, together with numerous closets, vaults, and storerooms. Generally there is an outer office or reception room, an office for a secretary or stenographer, and the principal's office. In many cases there is no direct passage from one office to the other. For economy of time and convenience there should be.

The writer can surmise two good reasons for the apparent lack of good planning in the administrative offices of large high schools. First, the large, new school is the outgrowth of an older and smaller school. The principal and faculty move from the old plant into the new. In planning his quarters the principal thinks of the old accommodations rather than of the needs of the new. Second, it is hard to convince many school boards of the necessity of having a group of complete, contiguous administrative offices. Board members, too, are accustomed to think largely in terms of the small school. Sooner or later the principal finds his administrative problems growing both in number and complexity. He learns that he must have more assistants and that they must have suitable offices. Frequently these offices are located in widely separated parts of the building.

For illustration let us take the Technical High School of Oakland, California. It grew out of the old Manual Training and Commercial High School, which had a normal enrollment of about six hundred pupils. When the faculty and pupils moved into the new plant the enrollment was slightly greater than twelve hundred.

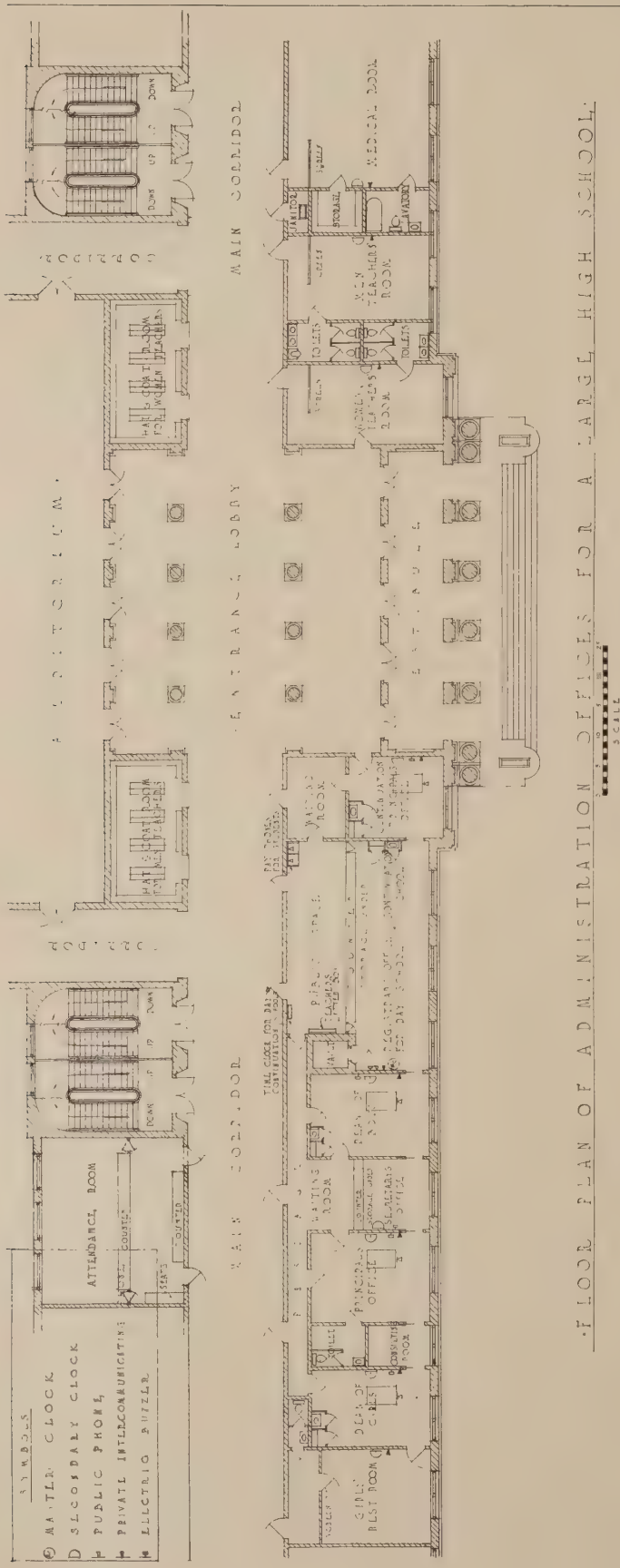


FIG. 218.

Within less than four years the new high school has reached an enrollment of over two thousand. In addition to this, during the past two years a continuation school[1] of more than two thousand adults has developed. Thus within a period of five years the school has grown in daily attendance from an enrollment of about six hundred to over four thousand pupils.

When the Technical High School opened its doors in Jan., 1915, the administrative offices consisted of a waiting room, a secretary's office, a supply room, a bath room, a toilet and lavatory, and the principal's office. That the offices were inadequate was evidenced by the fact that the two vice principals immediately sought offices outside of the administrative suite. These offices are far removed from the principal's and from each other. Much time is lost in walking back and forth for conferences, interviews, and the transaction of the usual school business.

The development of the continuation school required another suite of offices. These have been taken from space originally planned for the commercial department. They, too, are far removed from the other administrative offices.

The need for a centralization of administrative offices in the large high school has convinced the writer that the study of the problem is well worth while. No fixed plan will be suitable for all buildings. Every building presents its own special problems. We should not blame the school architect for all the mistakes that have been made in the plans of our school buildings. The writer knows several buildings in which mistakes have been forced upon the architect against his own best judgment.

After reviewing the plans of many modern high school buildings, we submit the following suggestive one.

General Plan. — (See figure 218.)

1. Registrar's office.
2. Office for the principal of the day school.
3. Office for the dean of girls.
4. Office for the dean of boys.

[1] During the fall term, 1918, the enrollment of the continuation school was as follows: afternoon session (2:15 to 4:40) 965; evening session (7:15 to 9:30) 3610; total enrollment, 4575. Of this number many attended only two or three sessions a week, thus giving a daily attendance of about 2000 for the continuation school. This was exclusive of the regular day school attendance, which was over 2000.

5. Office for the principal of the continuation school.
6. Attendance office.
7. Offices for heads of departments.

Registrar's Office. — The registrar's office should be on the first floor near the main entrance of the high school building. It should be a large, well-lighted, well-ventilated office. It should be separated from the public space by a high, wide counter. The rear of the counter should be fitted with cabinets for keeping blanks, office appliances, and supplies. On top of the counter, at either end, there should be a plate glass cover under which could be found the programs of the day and of the continuation school, also plans of the building and such other information as is most frequently needed.

At one end of the office there should be a vault for keeping money, permanent school records, and other valuables. The office should be equipped with substantial desks, chairs, and filing cases, preferably of quarter-sawed, antique oak. Here, also, should be installed the master clock, public telephone, and electric buzzers.

In the space reserved for the public outside of the registrar's office, there should be two public telephone booths. These should contain local and long distance pay telephones available for pupils and patrons. On the other side of the public space a time recorder should be installed for the use of the day and continuation school teachers and employees. Individual cards should be placed in a cabinet so that at any time, day or evening, the registrar could see at a glance whether teachers have reported in or out.

At the right of the public space is a door opening into a waiting room off the continuation school principal's office. This door is under the control of the secretary of the continuation school. Immediately to the right of the registrar's office is a private entrance to the continuation school principal's office. There is, also, an exit from the continuation school office to the main entrance.

Principal's Office. — Experience has shown that in a large, growing high school the main corridor on the first floor is nearly always crowded when classes are passing. School officials, parents, and visitors find it very difficult to go from one part of the building to another at such times. In order to obviate this difficulty we have planned an inner passage connecting the offices of the registrar, dean of boys, principal's secretary, principal, and dean of girls. To the left of the principal's office is a small consulting room. Just off from the consulting room is the office of the dean of girls. To the right of the principal's office is the office of the secretary. The plan shows an outer waiting room to the secretary's office. The two are separated by a high, wide counter, at one end of which is a gate. The inside of the counter is fitted with ample shelves and cabinets for keeping stationery and school supplies. At one end the top of the counter is covered with heavy plate glass. Under this may be kept the daily program of the school. The secretary controls the entrance to the principal's office on one side and to the dean of the boys on the other.

Office of the Dean of Girls. — The dean of girls has access to the consulting room opening at the right between her office and the principal's. On the left there is an entrance to the girls' rest room. It is advisable that the dean of girls should keep in touch with the girls' rest room. The latter place is sometimes abused by lazy or shiftless pupils, and it is highly desirable that the use of the room be restricted to those girls who are assigned by the dean.

Office of the Dean of Boys. — This office is located between the offices of the registrar and secretary. It is easy to pass through the waiting room of the secretary's office to the principal's office or to the registrar's immediately adjacent. The whole plan shows a fairly complete centralization of the administrative quarters. While the plan may seem elaborate, it really requires no more space than is usually found in widely separated quarters.

5. *Office of the Continuation Principal.* — The continuation school principal usually finds himself an unwelcome guest. In some schools his office is in a corner of the day school principal's office. This arrangement is neither satisfactory nor convenient. Furthermore, if the continuation school is to be conducted in the afternoon as well as in the evening, the continuation school principal should have his own quarters. The plan herewith presented (figure 218) provided such accommodations. It will be noted that the registrar's office is comparatively large. It was made so to accommodate the crowding which always occurs at the organization of the school term. By having one registrar's office for both day and continuation school there is a centralizing of information, of reports, and of records. Besides there is ample room for both day and continuation pupils. The office of the continuation school principal should be equipped with convenient filing cabinets and office appliances.

Adjoining the continuation school principal's office is a waiting room which may be used by prospective students and continuation school teachers.

6. *An Attendance Office.* — One of the big problems in a large high school is that of attendance. In some schools the attendance is handled by the dean of girls and dean of boys respectively. There are good reasons for having the attendance under the immediate supervision of these two administrative offices, but in the largest schools it would seem advisable to have a separate office for checking the attendance.

In the opinion of the writer the attendance office should be near the administrative quarters, located on the first floor not far removed from the locker rooms. One office properly equipped and furnished would be adequate for taking charge of the entire attendance problem. The usual filing devices and office fixtures should be installed.

7. *Offices for Heads of Departments.* — A study of the plans for large high school buildings does not always indicate the offices that are available for heads of departments and conference committees. The experience of school men has been that there are too few offices in the large high school. There ought to be at least one office for each five teachers. Since the large high school is coming to have continuous sessions, it is important that teachers have quarters where they may retire to plan their work and have conferences with each other, with parents, and with pupils. Not only should the heads of departments have good, well equipped offices, but there should be enough other offices for the different groups of teachers.

Experience has shown that the offices should never be placed inside of classrooms, but should have an entrance directly from the corridor.

CHAPTER XII

THE CLASSROOM

By John J. Donovan, *Architect*, A.I.A.

I. General Remarks. II. Size of Elementary Classrooms. (1) Width of Aisles. (2) Length and Width of Classrooms. (3) Floor Areas. (4) Chicago Board of Education Plan. (5) New York Board of Education Plan. III. Age of Pupils. IV. Size of Classroom Furniture. V. Size of High School Classrooms. (1) Boston High School Classrooms. (2) Ceiling Heights. (3) Further Study of the Plan. VI. Natural Lighting of Classrooms. (1) Overhead Lighting. (2) Glass Area. (3) Height of Window Stools. VII. Wardrobes. VIII. Blackboards. (1) Stock Sizes of Slate. (2) Heights of Chalk-Rails. (3) Tacking Strips. (4) Reach of Pupils. IX. General Notes. (1) Floors. (2) Trim. (3) Doors. (4) Transoms. (5) Plaster. (6) Canvas. (7) Painting. X. Floor Treatment. (1) Floor Oiling. (2) Floor Dressings. (3) Linoleum. (4) Linseed Oil and Turpentine. XI. Location of Air Registers. XII. Windows. (1) Shades. (2) Venetian Blinds.

That the classroom is the fundamental unit of the school organization is a truth that will bear constant repetition. And it is because of this vital fact that definite and detailed information in text and drawings should fully cover the latitude permissible in planning the classroom. In examining the plans herein presented, it will become obvious that, before establishing the size of the room, it is necessary to know the grade and maximum number of pupils that will occupy the room, and the type and size of the furniture. There are other questions which call for careful consideration and clear judgment, and in any discussion they are well worth attention before settling down to the final composition of the plan of the whole, which necessarily will include other units besides classrooms. Consequently, this chapter will treat on the subjects which pertain not only to the design, but also the general appointments and the hygiene of the room, such as the lighting, blackboards, floors, painting, etc., etc.

Size of Elementary Classrooms. — The width of the classroom is a very important factor in the plan of the school. Generally the number of rows of seats across the room is not less than five. But there are times when it is advantageous for other rooms, such as laboratories, that the classroom should have a width adequate for six rows. In a high school the wider room gives a more flexible arrangement for equipment in rooms above and below the classroom, or on the same side of the corridor. Many favor the wider classroom as the length of the room is thereby shortened, and it is easier for both teacher and pupils to hear and talk, and there is less eye strain to pupils occupying rear seats in reading matter on the front blackboard. On the other hand, the narrower room requires smaller structural spans and consequently is of less expensive construction. The ceiling heights also may be less for the narrower room. The length of the building, however, is reduced by the use of the wider classroom, provided of course the same number of pupils occupy the rooms of the five and the six rows.

Width of Aisles. — After determining upon the number of pupils and the size of the furniture, the width of the side, rear and inner aisles should be next considered. From the Boston data (figs. 225, 226, 227, 228, and 229) it will be noticed that the window aisle is 24″ wide for all classrooms, except for the larger high school rooms, where it is 28″ wide. The rear aisles vary from 36″ to 30″ and the inner aisles for grades I to VIII are 16″ and $15\frac{1}{2}$″, and in the high school grades 18″, while the wall aisles opposite the windows range from 5′ 4″ for the lowest grades to 3′ $0\frac{1}{2}$″ for the higher elementary grades and 3′ 6″ for high schools. There is quite a variation in widths of wall aisles in the Boston seating arrangement, due to the uniform size of the classrooms for all elementary grades.

Whenever blackboards are used at the side and rear of the room, and that is the general practice, it is well to allow not less than 2′ 8″ for width of space between the wall and the back of the seats, and 3′ 0″ for the wall aisles, as the latter is necessary for the free circulation of pupils. The space of 8′ 0″ is none too large for clearance between the front row of desks and the front wall, especially when the pupils pass in front of the teacher's desk on their way to the wardrobe. Actual investigation convinces the writer that inner aisles should not be less than 1′ 6″ in width.

Length and Width of Classroom. — Assuming the rear aisle is 2′ 8″ wide and the distance between the front row of seats and the front wall is 8′ 0″, the length of the room is determined by the number of seats to each row, which brings up the question of the number of pupils to a room. The writer has yet to meet a teacher who believes that the number should exceed forty, for reasons too numerous to enter into here except the very good reason that it is not fair to either child or teacher in receiving and giving instructions. Therefore, with forty or forty-two as the number to be considered, we may say that by establishing the length and width for the sixth grade for schools below the junior high, all lower grades will have plenty of room to spare.

The distance from back to back in the Boston seating arrangement for the 6th grade is 2′ $5\frac{1}{2}$″, while the market

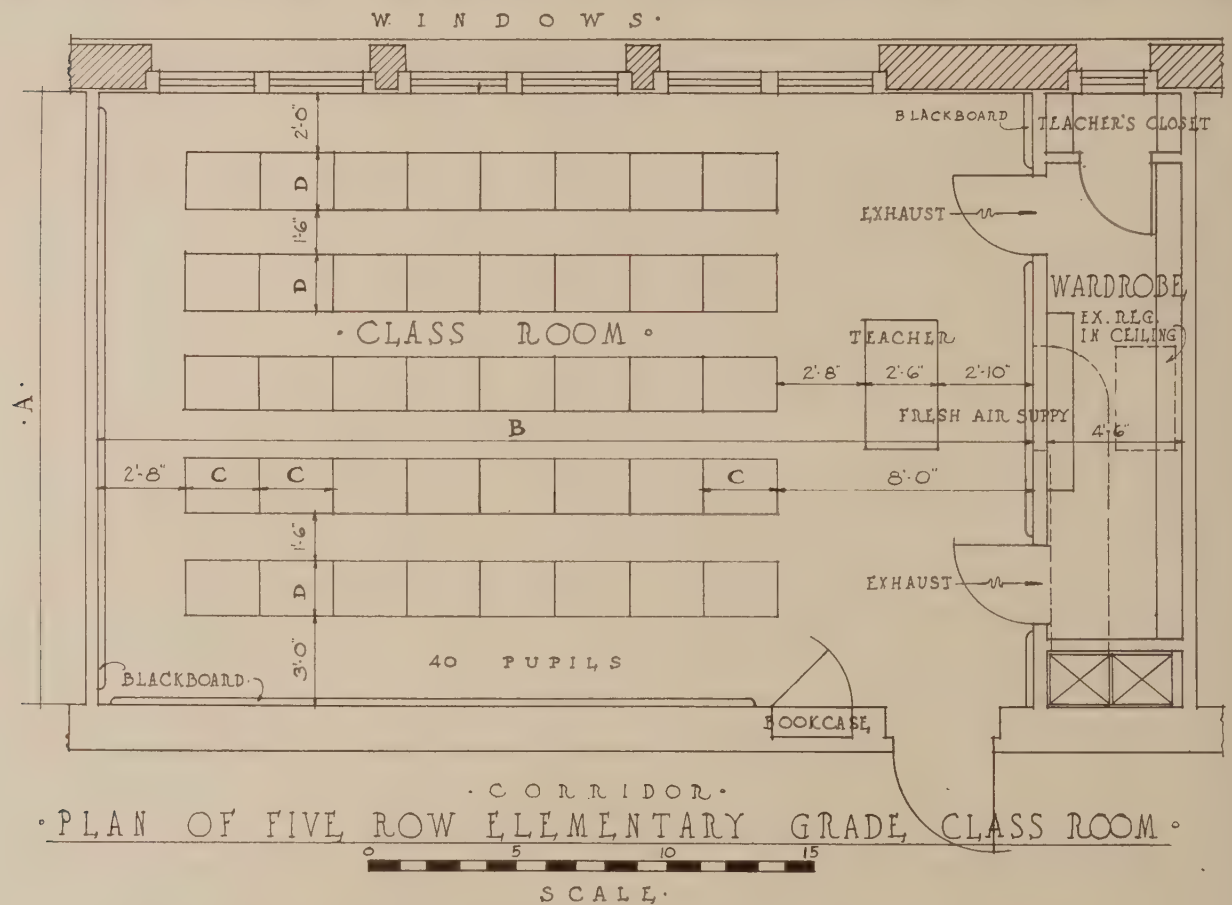


TABLE OF SIZES & MEASUREMENTS OF SCHOOL DESKS			
GRADES	I · II · III	IV · V · VI	VII · VII
WIDTH OF ROOM A	18'-6"	19'-9"	21'-0"
LENGTH OF ROOM B	27'-4"	30'-0"	31'-4"
DISTANCE BACK TO BACK C	2'-1"	2'-5"	2'-7"
DISTANCE ACROSS D	1'-6"	1'-9"	2'-0"
SIZE OF DESK	12" X 18"	15" X 21"	16" X 24"
HEIGHT OF DESK	21" TO 24"	23" TO 28"	26" TO 31"
AREA REQUIRED FOR GRADES	505.6 SQ.FT.	592.5 SQ.FT.	657.93 SQ.FT.
AREA PER PERSON	12.33 " "	14.45 " "	16.04 " "

FIG. 219.

sizes range from 2′1″ to 2′3″. Assume the distance to be 2′5″ for a five-row room, then a room of forty seats will require a length of 30′0″ and a six-row room of forty-two pupils will require a length of 27′7″. The *widths* would be 19′9″ and 23′0″ respectively. (See Figures 219 and 220.) For grades VII and VIII (Figures 219 and 220) with forty and forty-two seats to the five- and six-row rooms, respectively, and distance from back to back 2′7″, the *lengths* of these upper grade classrooms would be 31′4″ and 28′9″, while the *widths* would be 21′0″ and 24′6″.

Figures 221 and 222 illustrate two other types of classrooms with the wardrobes at the side and end, respectively, and both are used very much in the same way. Figure 222 is known as the "Chicago" type and like Figure 221 is favored by many architects of high standing in the field of school architecture. The writer favors the type with the wardrobe at the end of the room as in Figure 219, because it is possible to ventilate directly to the open air through the window, and what is equally important, if not more so, is the possibility of having sunshine fall within the wardrobe some time during the day, providing, of course, the classroom is not facing the north.

Floor Areas. — It may be of interest to note the floor areas, including wardrobes, of all three schemes, using the measurements for grades VII and VIII of desks and aisles common to all except that the side wall aisle of Figure 221 is 4′0″ wide instead of 3′0″, in order to allow more freedom in front of the wardrobe. The following are the areas:

Fig. 219. 21′ 0″×36′ 4″ = 762.3 square feet.
Fig. 220. 24′ 6″×31′ 4″ = 766.8 square feet.
Fig. 221. 21′ 0″×34′ 0″ = 714 square feet.

The "Chicago" type, Figure 222, is 48.3 square feet less than that of Figure 219 and 32.8 square feet less than that of Figure 221. Notwithstanding this difference I believe the value of the sunlight compensates for the increased floor area of Figure 219. While calling attention to floor areas including wardrobes it is interesting to observe that the total floor area of the six-row classroom, Figure 220, is 826.87 square feet, or 64.57 square feet greater than that of Figure 219, the five-row room. This difference is diminished if 32.76 square feet, the area occupied by the two additional pupils, is deducted.

Chicago Board of Education Plan. — Figure 223 shows the seating plan of classrooms for various size desks in the elementary grades as laid out by Mr. A. F. Hussander, Architect for the Chicago Board of Education. They are similar to Figure 221 and have the advantage of giving more blackboard space back of the teacher's desk.

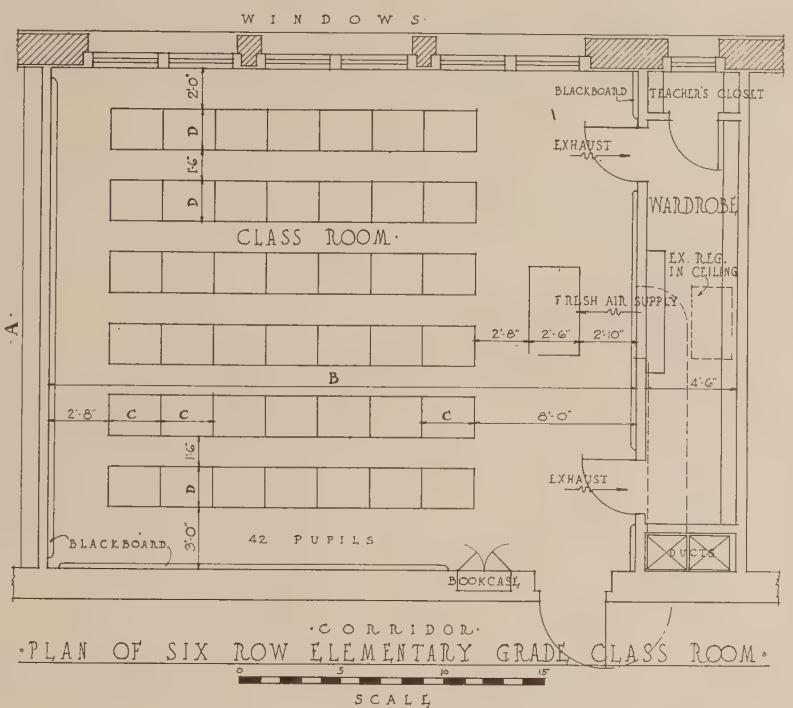


TABLE OF SIZES & MEASUREMENTS OF SCHOOL DESKS

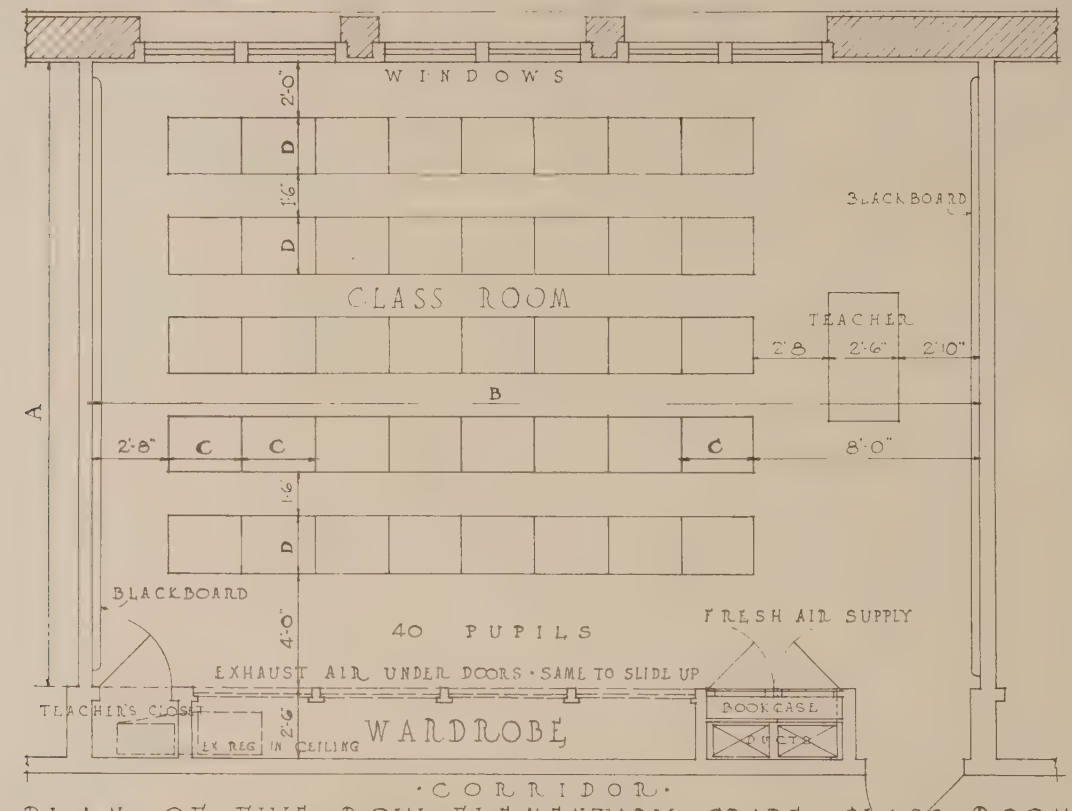
GRADES	I II III	IV V VI	VII VIII
WIDTH OF ROOM A	21'-6"	23'-0"	24'-6"
LENGTH OF ROOM B	25'-3"	27'-7"	28'-9"
DISTANCE BACK TO BACK C	2'-1"	2'-5"	2'-7"
DISTANCE ACROSS D	1'-6"	1'-9"	2'-0"
SIZE OF DESK	12"×18"	15"×21"	16"×24"
HEIGHT OF DESK	21" TO 24"	23" TO 28"	26" TO 31"
AREA REQUIRED FOR GRADES	542.87 SQ FT	634.34 SQ FT	704.37 SQ FT
AREA PER PERSON	12.62 " "	14.75 " "	16.38 " "

FIG. 220.

New York Board of Education Plan. — Figure 224 illustrates the elementary school classroom floor plans as planned by Mr. C. B. J. Snyder, Architect for the New York City Board of Education. The capacities are as follows:

48 seats and desks in grades 1-A to 4-B, inclusive.
46 seats and desks in grades 5-A to 6-B, inclusive.
42 seats and desks in grades 7-A to 8-B or 9-B, inclusive.

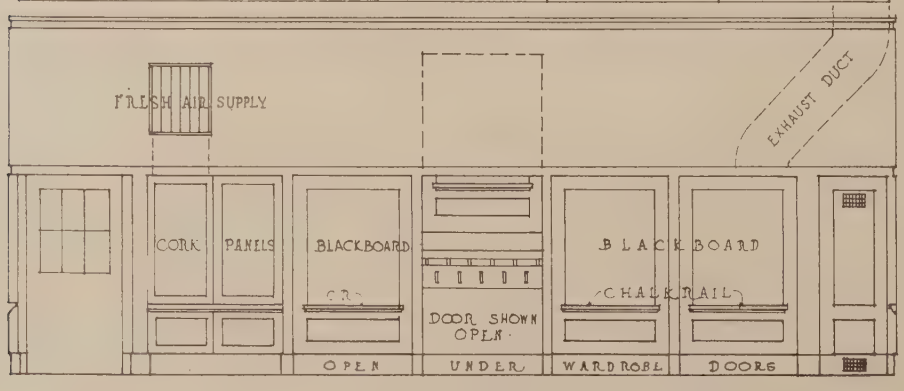
Age of Pupils. — The following information on this subject may be useful:



PLAN OF FIVE ROW ELEMENTARY GRADE CLASS ROOM.

TABLE OF SIZES & MEASUREMENTS OF SCHOOL DESKS.

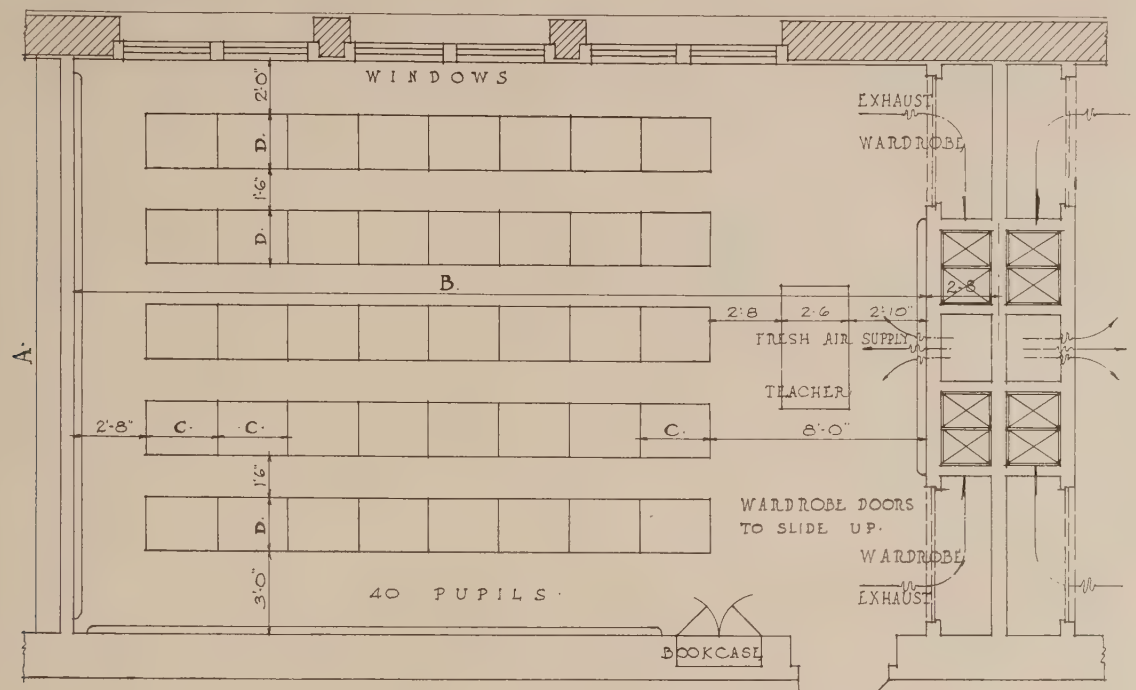
GRADES		I II III	IV V VI	VII VIII
WIDTH OF ROOM	A	19'-6"	20'-9"	22'-0"
LENGTH OF ROOM	B	27'-4"	30'-0"	31'-4"
DISTANCE BACK TO BACK	C	2'-1"	2'-5"	2'-7"
DISTANCE ACROSS	D	1'-6"	1'-9"	2'-0"
SIZE OF DESK		12" × 18"	15" × 21"	16" × 24"
HEIGHT OF DESK		21" TO 24"	23" TO 28"	26" TO 31"
AREA REQUIRED FOR GRADES		532.93 SQ. FT.	622.5 SQ. FT.	689.26 SQ. FT.
AREA PER PERSON		12.98 " "	15.18 " "	16.81 " "



ELEVATION OF WARDROBE SIDE.

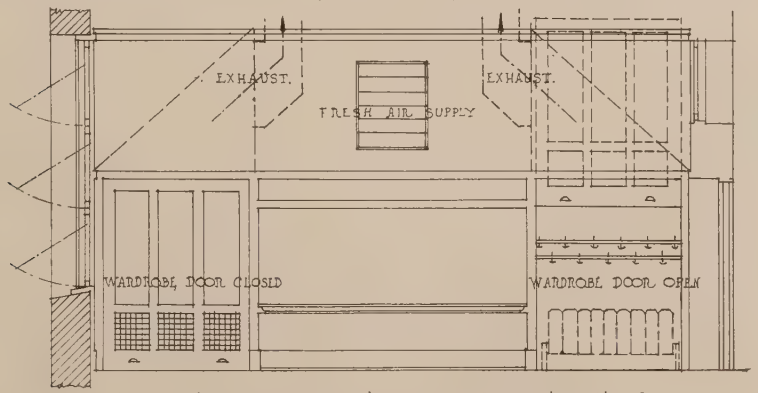
SCALE

FIG. 221.



PLAN OF FIVE ROW ELEMENTARY GRADE CLASS ROOM

TABLE OF SIZES & MEASUREMENTS OF SCHOOL DESKS			
GRADES	I II III	IV V VI	VII VIII
WIDTH OF ROOM A	18'-6"	19'-9"	21'-0"
LENGTH OF ROOM B	27'-4"	30'-0"	31'-4"
DISTANCE BACK TO BACK C	2'-1"	2'-5"	2'-7"
DISTANCE ACROSS D	1'-6"	1'-9"	2'-0"
SIZE OF DESK	12" × 18"	15" × 21"	16" × 24"
HEIGHT OF DESK	21" TO 24"	23" TO 28"	26" TO 31"
AREA REQUIRED FOR GRADES	505.6 SQ. FT.	592.5 SQ. FT.	657.93 SQ. FT.
AREA PER PERSON	12.33 " "	14.45 " "	16.04 " "

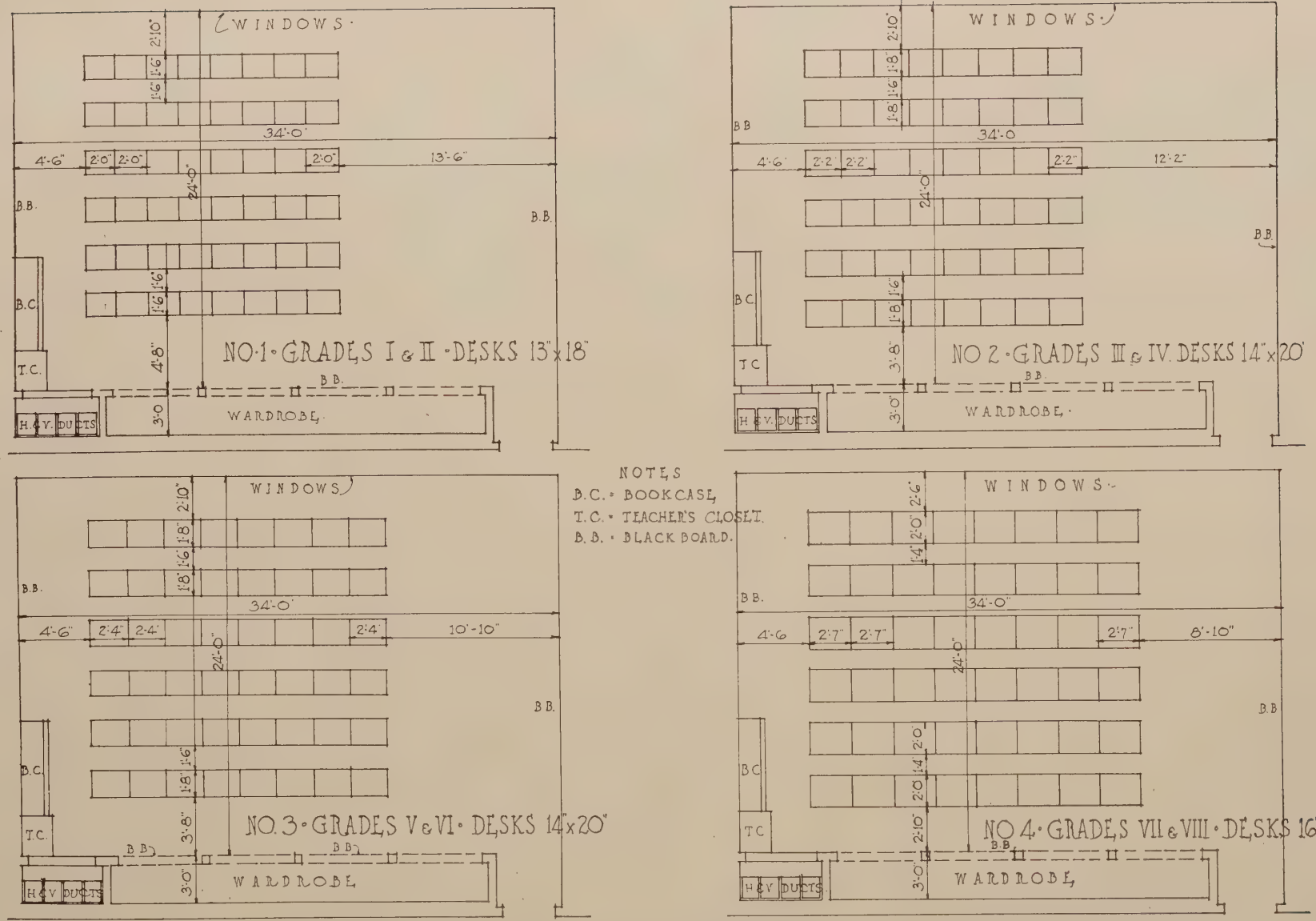


ELEVATION OF WARDROBE END

0 5 10 15

SCALE

FIG. 222.



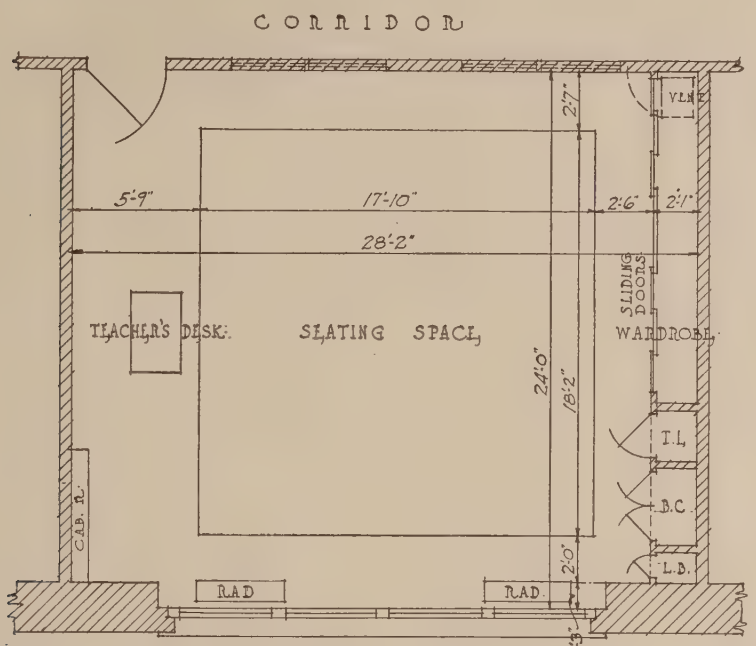
NOTES
B.C. = BOOKCASE,
T.C. = TEACHER'S CLOSET.
B.B. = BLACK BOARD.

SEATING PLANS FOR CLASS ROOM USED BY THE CHICAGO BOARD OF EDUCATION

A. F. HUSSANDER ARCHITECT 6-24-18

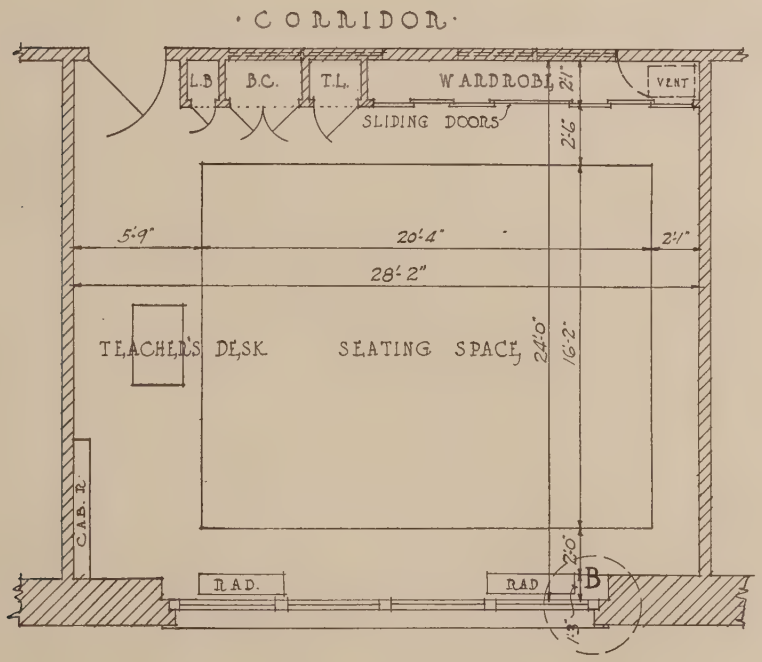
0. 5. 10. 15
SCALE.

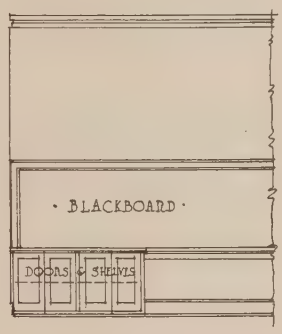
FIG. 223.



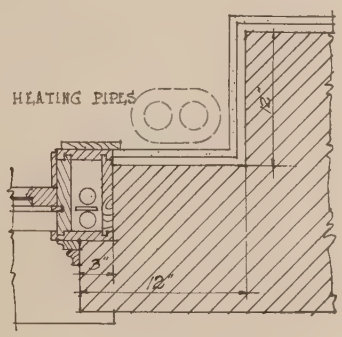
48 · SEATS & DESKS IN GRADES FROM 1A · TO · 4B · INCLUSIVE,
46 · SEATS & DESKS IN GRADES FROM 5A · TO · 6B · INCLUSIVE,
42 · SEATS & DESKS IN GRADES FROM 7A · TO · 8B OR 9B INCLUSIVE,
CAB. R. = SUPPLY CABINET
T.L. = TEACHERS LOCKER
B.C. = BOOK CABINET
L.B. = LIBRARY BOOKCASE.

· PLAN OF CLASSROOM WITH WARDROBE AT REAR ·





ELEVATION OF SUPPLY CABINET UNDER BLACKBOARD



· PLAN AT B ·

PLAN OF CLASSROOM WITH WARDROBE AT SIDE

0 5' 10' 15'

· SCALE ·

TAKEN FROM DRAWINGS OF PUBLIC SCHOOL NO 29 · MR. C.B.J. SNYDER ARCHITECT ·

FIG. 224.

Kindergarten:
entering age 5, completing age 6.
Elementary School:
Grade No. 1: entering age 6, completing age 7.
Grade No. 2: entering age 7 to 7½, completing age 8 to 8½.
Grade No. 3: entering age 8 to 8½, completing age 9 to 9½.
Grade No. 4: entering age 9 to 10, completing age 10 to 11.
Grade No. 5: entering age 10 to 11, completing age 11 to 12.
Grade No. 6: entering age 11 to 12, completing age 12 to 13.
Intermediate or Junior High School:
Grade No. 7: entering age 12 to 13, completing age 13 to 14.
Grade No. 8: entering age 13 to 14, completing age 14 to 15.
Grade No. 9: entering age 14 to 15, completing age 16 to 17.
Senior High School:
Grade No. 10: entering age 14½ to 17, completing age 15½ to 18.
Grade No. 11: entering age 16 to 18, completing age 17 to 19.
Grade No. 12: entering age 17 to 19, completing age 18 to 20.

Size of Classroom Furniture. — The following table of sizes for school desks has been made up from a prominent manufacturer's catalogue (all dimensions are in inches):

Size numbers	1	2	3	4	5	6
Length of desk top	23½	23½	20½	20½	17½	17½
Width of top	16	16	14	14	12	12
Height of top	30	28¼	26½	24¾	23	21¼
Height of seat	17¼	16	14¾	13½	12¼	11
Age of pupils (years)	17	14	11	8	6	5

Size of High School Classrooms. — The principles to be observed in planning the high school classroom are practically the same as for the elementary school. The main exception is that, in the high school, locker rooms for clothing and books are located in other parts of the building and the wardrobe of the elementary school disappears. The blackboards are of different heights, and the bookcase, with its dictionary, is used more by the students; the hanging rail above the blackboard is omitted; and there should be consideration given to the circulation if movable furniture is used.

In establishing the size of classrooms for a high school a careful survey ought to be made of the enrollment for instruction in the different subjects of the curriculum. A capable superintendent or principal should be the master of this situation, for wasteful space or cramped rooms may result from a plan in which all the classrooms are of the same size. For example, the first and second year classes are, as a general rule, much larger than the third and fourth year classes, and some subjects of all years have larger attendance than others. Subjects like mathematics, modern languages, and particularly the dead languages, Greek and Latin, most likely have a smaller attendance than subjects like history, English, or similar subjects which are mostly lecture and outside reading courses.

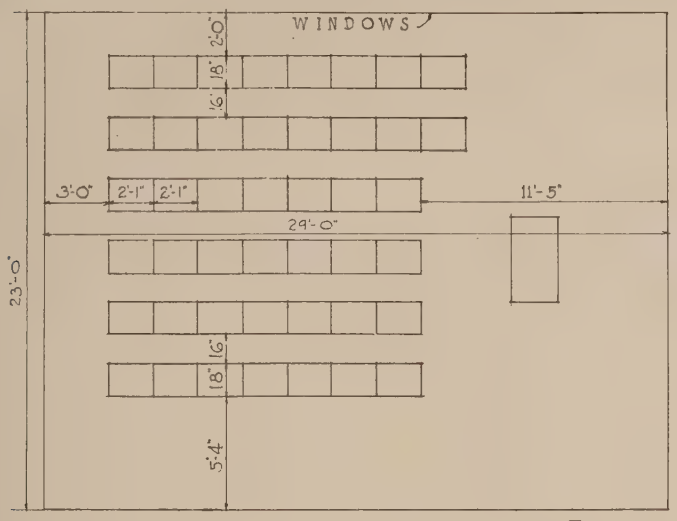
Very often folding doors and rolling curtain partitions are used as partitions separating rooms, so that two or more of the classrooms may be thrown together. It is easier to do this with movable chairs than with the fixed desk and seat. Although it is not always convenient to join rooms like this, it is much better than to be unable to enlarge classrooms quickly. A good plan is to have all heating and ventilating ducts, plumbing pipes, electrical conduits, and such work installed in the corridor walls or extend along and furred in the corridor ceilings, and have the floors supported by the corridor partitions only, so that dividing or cross partitions may be moved and reset as often as the occasion warrants. Very little expense or damage is incurred if the partitions alone have to be moved.

Boston High School Classrooms. — Figures 228 and 229 show the seating arrangement for high school classrooms as adopted by the Boston School Commission for classes of eighty and forty-two desks. Rooms are also laid out to accommodate sixty and thirty-six, while recitation rooms 26′ 0″ × 16′ 0″ are used as classrooms with double desks providing seats for about thirty pupils. The natural lighting of the larger rooms is a special problem and should be considered as such. Figure 230 shows a seating arrangement for junior and senior high schools often used by the writer, which has been found to work out quite satisfactorily.

Ceiling Height. — After having settled upon the horizontal dimensions of the room the height of ceiling from floor should receive careful consideration for proper lighting and ventilation. The first step is to investigate if near-by building or buildings on the opposite side of the street are of such a height as to prevent direct rays of sky light from entering at the sill line of the window of the classroom on the lowest floor at an angle not greater than 27 degrees with the horizontal. If the street is too narrow or the adjacent buildings too high then the school building must be set far enough back from the street to correct this. At this point it is evident that the selection of the site is no small matter.

Assuming that the site is large enough to locate the building as desired the height of ceiling from floor should be determined by the amount of direct light falling upon the row of desks most removed from the windows.

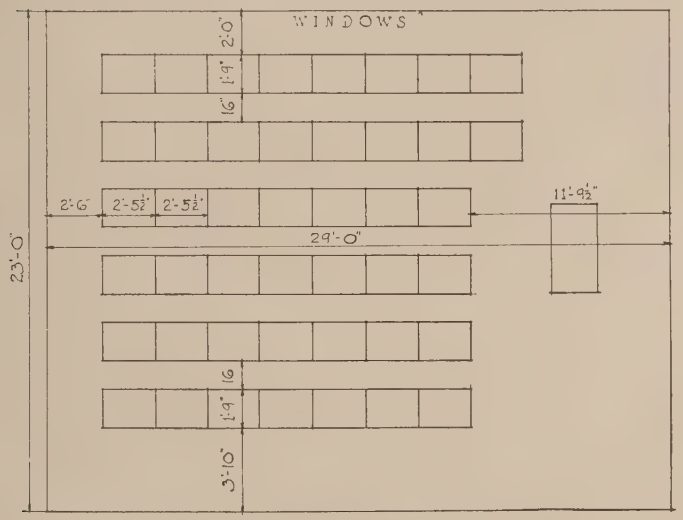
The rule that the classroom should not be wider than twice the height of the window head from the floor and that the rays of light be direct sky light, necessitates the placing of the building so that the height of the top of structures opposite from the sill line of the lowest classrooms will not be greater than one-half the distance between both buildings. Figure 233 illustrates this principle, and except in cities like New York, with an "East Side" where the streets are narrow, it is not difficult to obtain the direct sky rays. This rule will indicate how close walls of courts or yards may be without jeopardizing the lighting of the rooms.



44 DESKS

FIG. 225.

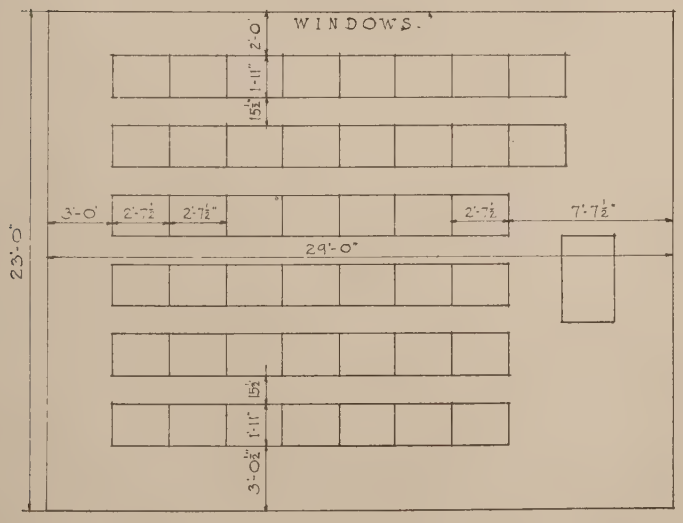
GRADES I & II 12"×18" 24½" BACK TO BACK
GRADE III " 25" " "



44 DESKS

FIG. 226.

GRADE IV 15"×20½" 2'-4" BACK TO BACK
" V 15"×21" 2'-4½" " "
" VI 15"×21" 2'-5½" " "

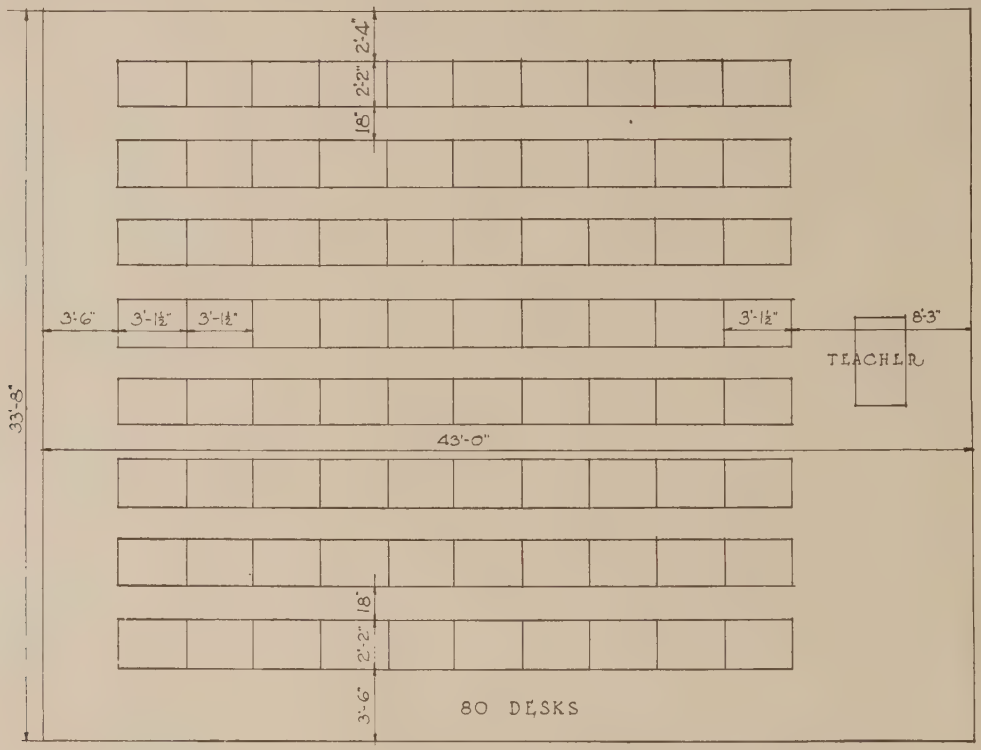


44 DESKS

FIG. 227.

GRADE VII 16"×23" 2'-7" BACK TO BACK
" VIII 16"×23½" 2'-7½" " "

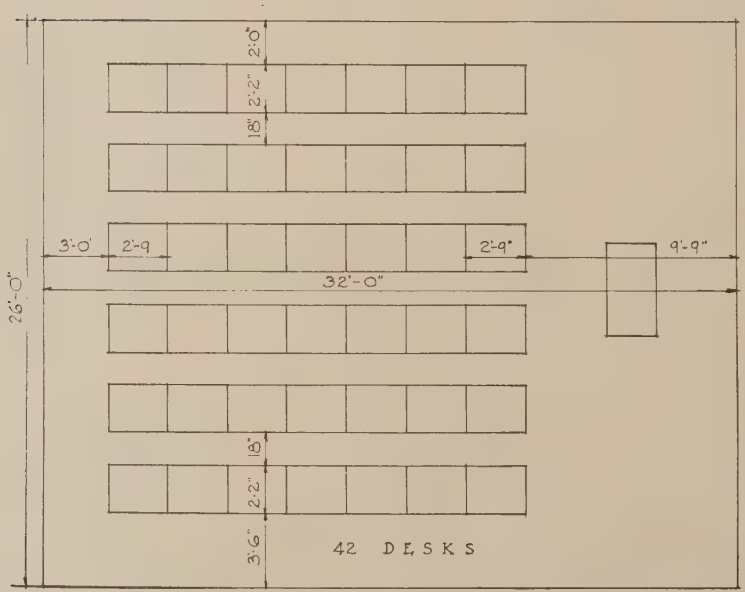
CEILING HEIGHT 12'-0"
AREA 667 SQ. FT.
ALLOWS 14.82 " " PER PERSON
VOLUME 8004 CU. FT.
ALLOWS 177.84 " " PER PERSON



HIGH SCHOOLS. FIG. 228.

SIZE OF DESKS 20" X 26"
BACK TO BACK 3'-1½"

AREA 1447.38 SQ. FT.
ALLOWS 17.86 " " PER PERSON
VOLUME, 17,368.56 CU. FT.
ALLOWS 214.42 " " PER PERSON



CEILING 12'-0" HIGH

AREA 832 SQ. FT.
ALLOWS 19.34 " " PER PERSON
VOLUME, 9,984 CU. FT.
ALLOWS 232.18 " " PER PERSON

HIGH SCHOOLS

SIZE OF DESKS 20" X 26"
BACK TO BACK 2'-9"

SCALE.

FIG. 229.

Figures 234 and 235 demonstrate the rule on a larger scale, and the direction of the rays of light within the classroom. Figure 235 is a section of the upper grade classrooms (VII, VIII, and High Schools), while Figure 234 is a section of the classrooms of grades I to VI inclusive. Taking Figure 235 first, it should be noted that the desks range from 2′2″ to 2′7″ in height, the width of desks is assumed at 2′0″, the window aisle is 2′0″, the aisles between desks are 1′6″, and the wall aisles opposite the windows are 3′0″. Also the dotted line X–X′ is the inner wall line for a room of five rows, and Y–Y′ the wall line for a room of six rows. It can be seen that for a ceiling height of 12′0″ the ray C from the lintel of ceiling height 12′0″ falls beyond one-fourth of the high desk of the fifth row, and that ray F from the lintel of ceiling height 13′6″ just intersects the corner of the larger desk of the sixth row. The window lintels are assumed to be 6″ below the ceilings. It should be noted that the distance from the outside wall of the innermost rows of desks receiving proper light in each case is approximately one and one-half times the height of the window head from the floor. Therefore, it may be stated as a general rule by which to establish the arrangement of the seating and width of the room for good lighting, that no desk should be further removed from the source of light than one and one-half times the height of the window head from the floor.

From Figure 235 the deduction may be made that for a room of five rows in width a ceiling height of 12′0″ is sufficient, and for a room of six rows the height should be 13′6″ and never less than 13′0″. In Figure 234, with the desks 1′9″ in width, which is the market size for children of the sixth grade, and 2′4″ the height of the high desk for this grade, the lighting conditions are still more favorable. For a room of five rows it would be favorable to lower the ceiling to even 11′0″, although this would necessitate extending the horizontal length of the windows to bring the glass area up to 20 per cent of the floor area, and would reduce the volume of space in the room. However, this would be drawing too fine a line; it is mentioned only to demonstrate further the lighting problem.

Further Study of the Plan. — A final word regarding the study of the plan of the classrooms would not be amiss. The data presented are suggested with a desire to provide comfortable seating and aisles for easy circulation of pupils, as wel as to indicate where wise economies may be exercised in planning school buildings. Classrooms too large for the number of pupils to be accommodated are not only a financial and material waste, but, worse yet, they are a temptation to overcrowd such rooms just as soon as the slightest congestion develops in the community. This leads to neffi-ciency on the part of the teaching and cuts down on the individual instruction to the pupil. On the other hand there is a danger of attempting too great economy, and causing congestion and discomfort. The school is developing and changing so rapidly to meet new and added requirements that it behooves all who have to do with the housing of it to study each problem by itself, using such data as are presented here, simply as a means of solving the problem. Furthermore, when the school is used by continuation and evening classes the physical difference between high school students and adults requires consideration and study in order that the plant and its equipment may be flexible to meet the various requirements. Fixed and hard rules, however good and economical, often lead to permanent difficulties. The time may not be far removed when classrooms in elementary grades will vary in size to accommodate from as few as fifteen seats to as many as forty. Elastic classification will shorten the years of attendance of the mentally bright, and advance the slow child by more individual instruction, thereby moderating the financial burden of the state and giving greater opportunity to the child for advancement in educational work as well as development of its mental capacity.

If the school grades of cities are of the 6–2–4, 6–3–3 or 6–6 groups instead of the prevailing 8–4 plan, it is clear that the elementary classroom may be reduced in floor area. When housing the eight grades under one roof, it is necessary to make the width of the classroom of the size to accommodate the larger children, unless we resort to unsymmetrical plans which would discount in a measure any such economy in the elementary schools, since it costs more to build irregular-shaped buildings. A study of the classrooms of the Boston and Chicago groups discloses the fact that there is considerable unused space in the lower grades, due to the use of a uniform size for all elementary grades. This may be lessened if the width of rooms for the sixth grade is taken as the width for all grades below the sixth, and they are housed apart from the upper grades.

Natural Lighting of Classrooms. — The most important factor in the plan of a school is natural lighting. Artificial lighting is a matter of good illuminating engineering, but good natural lighting requires careful consideration in both plan and elevation with regard to the points of the compass and the quantity and quality of the light. Consequently the selection of the site and the location of the building are of paramount importance, for poor judgment in either case will make it difficult to favorably orientate classrooms and often will necessitate juggling and misplacing of rooms in order to overcome obstacles springing from the choice of an unsuitable site.

Range of seasonal temperature and geographic locality are factors which largely determine the orientation of the classrooms. It is unwise to lay down hard and fast rules for all sections of a country as large as the United States, for what is desirable in the New England and the Eastern states might prove severe for Southern and Western states, especially in many sections of these states where the range of temperature is high. Generally where high temperatures are not of long duration east and west lighting are most favorable for classrooms. In communities where the opposite is true the classrooms should be favored with east light, and to obtain economy it is sometimes necessary to resort to lighting from the north. This, however, should be a last resort, for a classroom which does not receive sunlight at some time during the day is deprived of a natural hygienic cleansing, and a cheerfulness which inevitably affects the health and happiness of pupils and the teacher. In many localities close to the oceans southern exposures are not harmful, but as a rule they should be avoided, for they require drawn shades for so long a period to shut out the glare of the sun as to deprive the room of the proper amount of light. This is just as bad as though the glass area was too small.

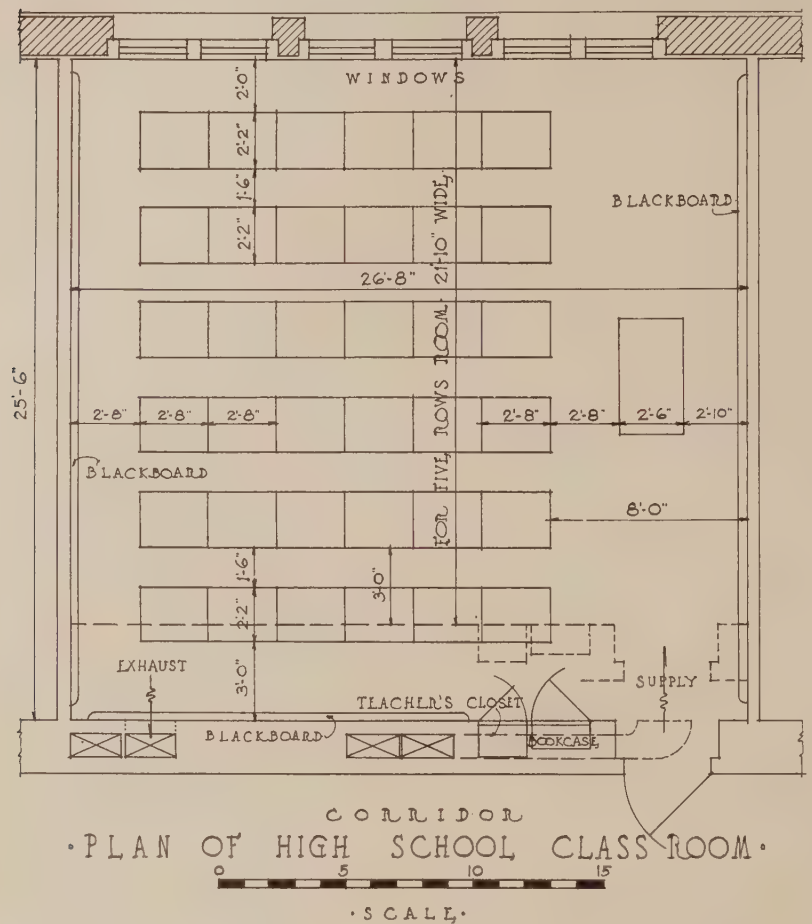


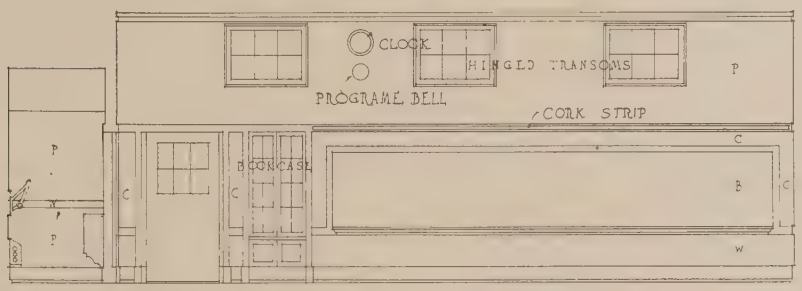
TABLE OF SIZES & MEASUREMENTS		
NO. OF ROWS	5 ROWS WIDE	6 ROWS WIDE
WIDTH OF ROOM	21'-10"	25'-6"
LENGTH OF ROOM	26'-8"	26'-8"
DISTANCE BACK TO BACK	2'-8"	2'-8"
DISTANCE ACROSS	2'-2"	2'-2"
SIZE OF DESK	16" TO 18" X 26"	16" TO 18" X 26"
HEIGHT OF DESK	2'-8"	2'-8"
FLOOR AREA REQUIRED	581.98 SQ. FT.	679.83 SQ. FT.
AREA PER PERSON	18.77 " "	18.37 " "

FIG. 230.

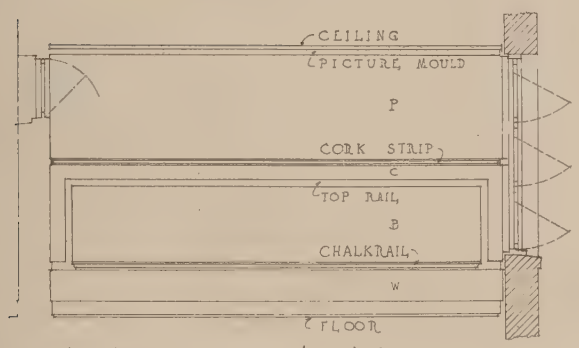
Overhead Lighting. — Overhead lighting for classrooms is adopted by some architects, but while it has the advantage of giving a uniform distribution, the writer cannot see any really good reason to recommend it, because of the confining impression created by the four walls extending to the ceiling with no outlook. Such lighting is appropriate for art rooms, shops, or operating rooms in hospitals, where moving about is permitted and when the steady blue sky light casts the desirable shades and shadows, but to continually confine children to such rooms seems like fitting them mentally to occupy cells.

Glass Area. — The right amount of glass area for a classroom likewise is dependent upon the locality and the orientation of the room. Classrooms facing the north should have a greater lighting surface than those having other exposures, and schools in communities that experience a preponderance of cloudy and foggy weather require more light than those that have an intense sunlight. The common practice is to allow 25 per cent of the floor area for masonry openings, which will give a trifle more than a 20 per cent equivalent in glass area. This should be closely followed, although in interior cities where the sunlight is quite intense, classrooms have been found to be fairly well lighted with as small a glass area as 16 per cent. This, however, is bordering too closely on the danger of underlighting.

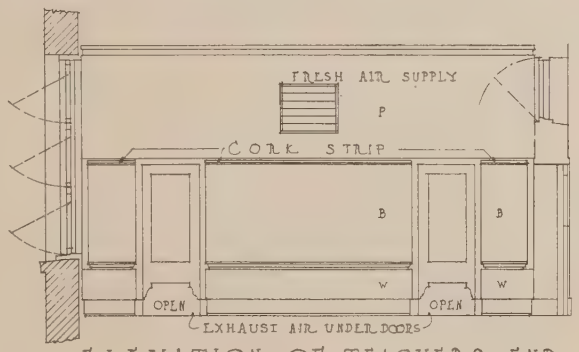
SIDE ELEVATION TOWARD EXTERIOR



SIDE ELEVATION TOWARD CORRIDOR

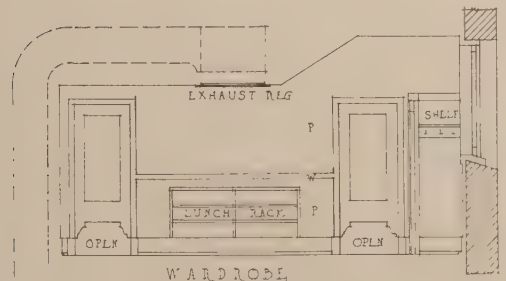


ELEVATION OF REAR WALL

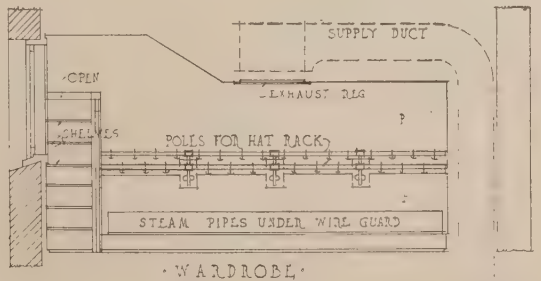


ELEVATION OF TEACHERS END

B = BLACKBOARD P = PLASTER
C = CANVAS W = WOOD PANELS



ELEVATION TOWARD CLASS ROOM



ELEVATION AWAY FROM CLASS ROOM

INTERIOR ELEVATIONS OF CLASS ROOM FIG.

SCALE.

FIG. 231.

Many states provide by statute for 20 per cent of glass area, and it should be followed, or increased whenever the climatic conditions require an increased area for good lighting.

One of the difficulties encountered by the architect in designing the exterior of a school building is the repetition of groups of windows of similar forms, which gives an impression of monotony. Nevertheless it is mandatory that the fenestration of classrooms conform to the physical requirements and that the rules governing these requirements be followed. It is unfortunate if the exterior design is unsightly, due to unskilled handling of windows; on the other hand, next to structural safety the proper lighting takes precedence over everything else. Furthermore, the vertical divisions or mullions and the horizontal divisions or transom bars should be as small as good construction will permit. By the use of steel sash both divisions are reduced to the minimum; but such sash are expensive. The transom bar is not necessary, for the double-hung and the horizontal casement sashes (Figures 236 and 237) may extend from stool to head without interruption except at the meeting rails.

Height of Window Stools. — Educators differ as to the ideal height of window stools, but the greater number believe that the height should not be less than 2′6″

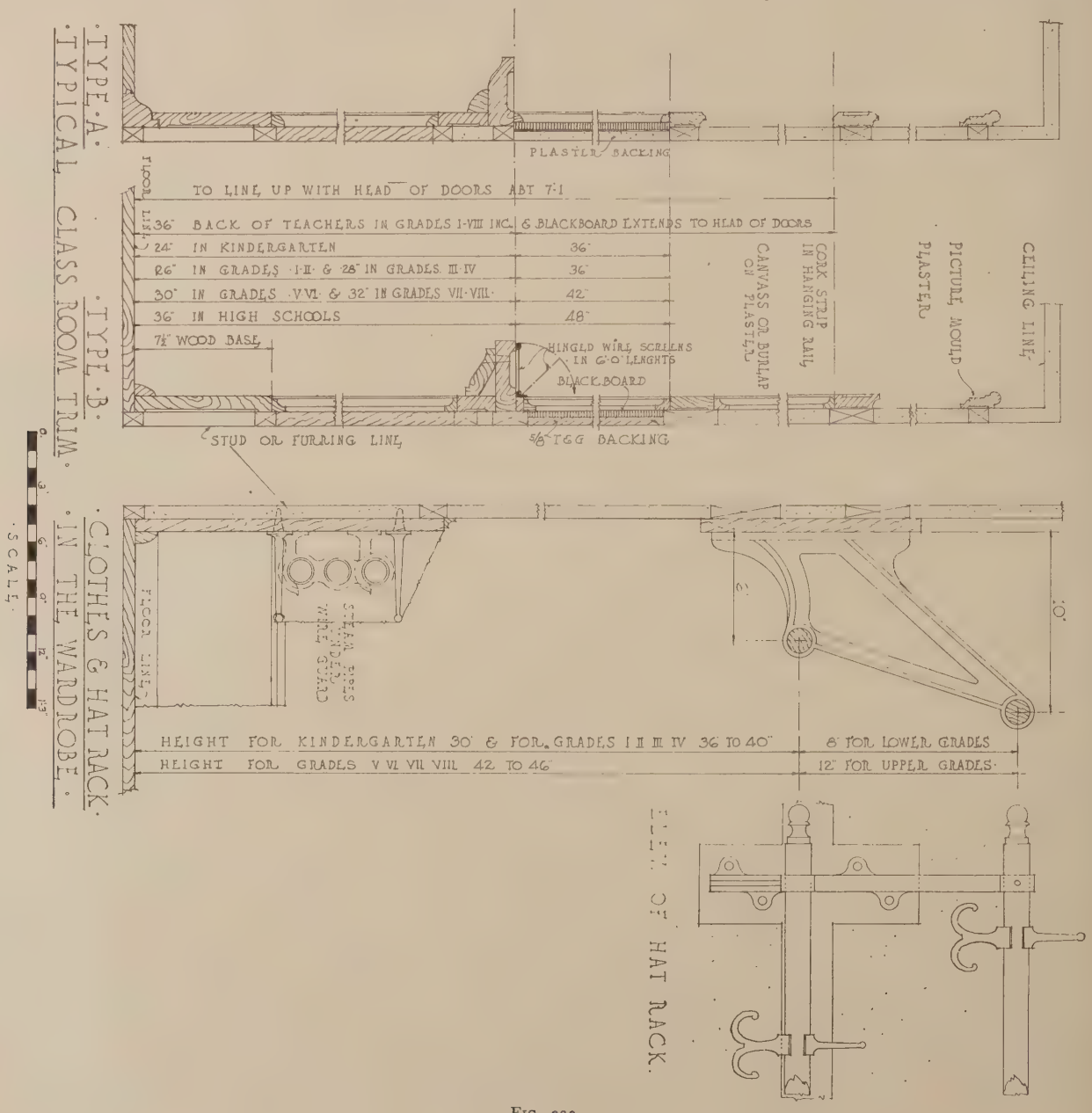

TYPE A.
TYPICAL CLASS ROOM TRIM.
TYPE B.
CLOTHES & HAT RACK.
IN THE WARDROBE.
SCALE.
PLASTER BACKING
TO LINE UP WITH HEAD OF DOORS ABT 7·1
36" BACK OF TEACHERS IN GRADES I-VIII INC. & BLACKBOARD EXTENDS TO HEAD OF DOORS
24" IN KINDERGARTEN 36"
26" IN GRADES I-II & 28" IN GRADES III-IV 36"
30" IN GRADES V-VI & 32" IN GRADES VII-VIII 42"
36" IN HIGH SCHOOLS 48"
7½" WOOD BASE
HINGED WIRE SCREENS IN 6·0 LENGHTS
BLACKBOARD
CANVASS OR BURLAP ON PLASTER
CORK STRIP IN HANGING RAIL
PLASTER
PICTURE MOULD
CEILING LINE
STUD OR FURRING LINE
⅝" T&G BACKING
FLOOR LINE
STEAM PIPES WITH GUARD
10'
HEIGHT FOR KINDERGARTEN 30" & FOR GRADES I II III IV 36 TO 40" 8 FOR LOWER GRADES
HEIGHT FOR GRADES V VI VII VIII 42 TO 46" 12" FOR UPPER GRADES
END OF HAT RACK.

FIG. 232.

and not more than 3′ 6″. If lower than 2′ 6″, glaring reflected light from the ground and surrounding objects will shine directly into the eyes of the pupils sitting near the windows, which is extremely harmful as well as annoying. If the window stool is higher than 3′ 6″, it is difficult for the child to look out for a momentary restful change, and it is on this point that educators disagree. Some contend that distraction results from low window stools. A large majority of educators, however, favor giving the child the same opportunity as is enjoyed by the teacher. But one of the determining factors regarding this point is the requirement of

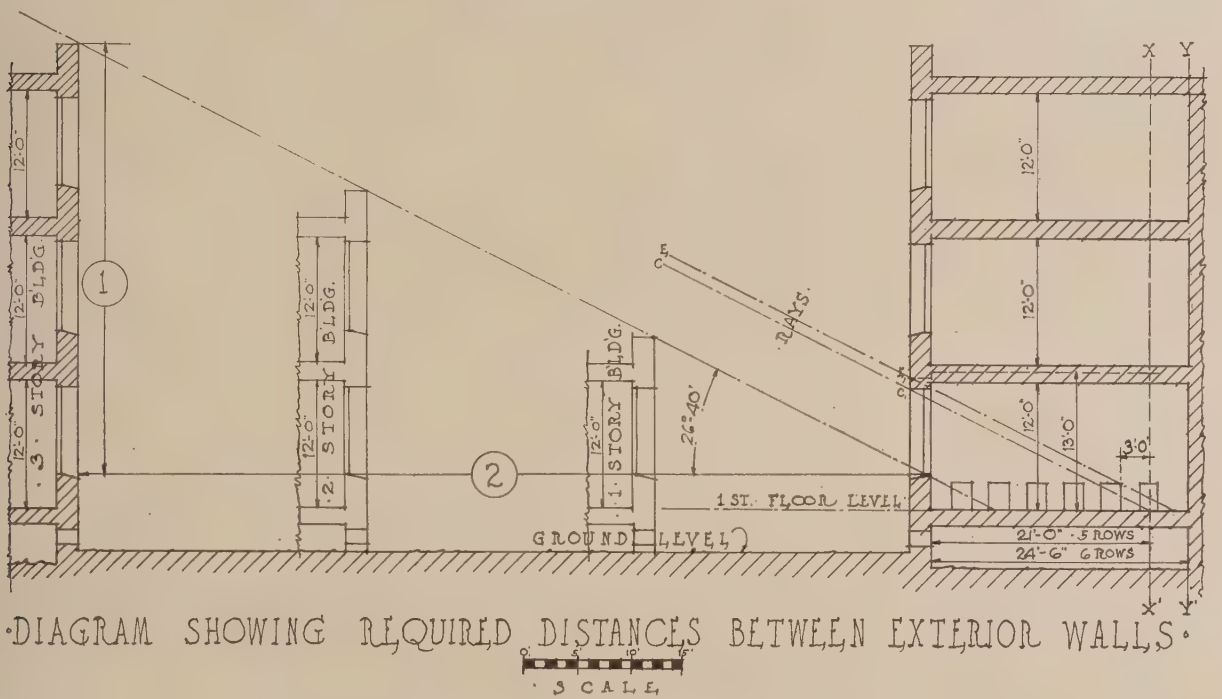


FIG. 233.

classroom, and the advantage to good lighting gained by it compensates but little for the psychologically bad effect upon both community and student caused by warped exteriors. After all, the precepts conducive to good natural lighting are left-hand unilateral light, the right kind of light, and the right amount of light. The latter two factors are entirely dependent upon the architect's grasp and solution of the problem.

Wardrobes. — It is possible to locate the wardrobe in the front, rear, or side of the classroom. Figures 219 and 220 show the wardrobe at the front; Figure 221 shows it at the side, while in Figure 222, known as the "Chicago" type, it may be at the front or rear. As previously mentioned, the "Chicago" type requires less floor area and does not increase the cost of construction due to width of room, as in Figure 221. However, the latter gives more room for the clothing, which is well worth considering. Access to both types is by means of vertically sliding panel doors, containing blackboards, counterweighted for easy operation.

glass area. It will be found that to meet 20 per cent equivalent, both the head and stool are almost automatically fixed, at least to only a slight range of variation. The soffit of the window head is usually not more than six inches below the ceiling line, and wherever the lintels can be splayed, just that much more light is given to the room. It is desirable that the masonry reveal on the left of the group of windows extend so far to the rear of the classroom as the rear seat, and on the right not much farther forward than the front line of desks, although I do not believe that the exterior appearance of a school should be marred to bring this about.

Many think well of the long blank space in the exterior wall adjacent to the front of the room, counting on this space to partially intercept the rays of light from that angle. A close examination will disclose the fact that this benefits but a small percentage of the pupils of a

Figures 219 and 220 show the type having an outside window, which gives direct lighting and natural ventilation. They are favored by many for these reasons and are more hygienic. It should be noted that the partition between the teacher's closet at the window does not extend to the ceiling but stops just above the top of the door. Also the upper panel of the door is glazed, permitting light to pass through.

The teacher's closet is found to be very convenient

and inexpensive. In addition to its other uses it is handy for the storage of supplies. Figure 232 shows the details within the room for the hanging of clothes for all three types of wardrobes. The hooks are usually spaced 12 inches on centers on each rod, making the net spacing about 6 inches on centers. While the heights of the rods are marked on the drawings, it may be well to record them here. For kindergarten the lower pole is thirty inches from the floor; for grades I, II, III, and IV, thirty-six to forty inches; for grades V, VI, VII, and VIII, forty-four, forty-eight, and fifty-two inches.

The steam coils are placed in the location shown, so that during inclement weather wet and damp clothing may be dried before recess or closing time. The clothing is protected from the hot coils by a $\frac{3}{4}''$ mesh wire guard covering the pipes as shown. Shut-off valves are placed in the teacher's closet and under her control The cost of this installation is so small that it should never be omitted. Very often the exhaust register or vent opening, without a register, is placed at the floor level in the wardrobes. It is better, however, to have the vent register placed in the ceiling, for then the travel of the air will cause it to pass through the children's clothing, ventilating and drying them. Referring to the section of the classroom looking toward the teacher's end of the room (figure 231), it is seen that the doors of the wardrobe are hung with the lower edge about 15 inches above the floor; while this is not as neat in appearance as the door containing the bottom rail and metal grille, nevertheless it is more efficient in ventilating the room, as there is no obstruction to the flow of the air where heaviest at the floor level.

Some school boards require an umbrella gutter extending the length of the wardrobe, but the umbrella rack is more sanitary, less expensive, and less cumbersome. The wardrobe should always be confined within the walls of the classroom and never be a part of the corridor or open out into the corridor. The former gives to the teacher complete control of this space, and eliminates petty pilfering and unsightly corridor walls or pockets. Furthermore, it must be remembered that at times of danger and fire drills the children are never permitted to go to the wardrobe for their clothing, as that would be the surest way to create confusion and engender panic.

Blackboards. — The question of blackboard material is bound to rise in any new school building project, and invariably the merits of the various materials are discussed, and often with very limited data at hand to enlighten the discussion. Not infrequently the final result of such deliberations is determined by the prevailing influence of a good salesman. The points to consider in selecting blackboard material are smoothness of surface, durability, porosity, possibilities for washing and erasing, non-reflectiveness of light, uniformity in color and permanency in shade. There is no material that will qualify to the test of the above requirements as well as good natural slate. Slate is a natural rock, the distinguishing characteristic of which is to split readily into thin layers. The molecular structure is very dense. Hence it is readily polished to a very fine, smooth, non-porous surface. Glass blackboards are used to a great extent in European countries and to some extent in this country, and it appears, from letters at hand, with varying degrees of satisfactory results. It has proved satisfactory in the chemistry department of the New York City College, while at the Carnegie Technical School, a correspondent complains of strong reflection of light and recommends against its use. However, glass blackboards have been so little used in this country that it seems at this time like experimenting with the little-known to attempt their general use, which is all the more unlikely as the cost is considerably higher than that of slate. Substitutes for slate are usually of patented make. The most common are made from wood pulp, paper, and cement, others from pulverized steel filings mixed with ground slate and set with a stone cement.

In school buildings of any permanency natural slate blackboards should be used. If they are of good material and have what is known as hand-shaved, or rubbed, velvet smooth finish no substitute is comparable in any way except in cost. A good method of determining the quality of smoothness is to draw long chalk lines upon it and note the continuity or unbrokenness of the line. If the lines appear to be short dashes or if the black is visible through the chalk line, then the finish is of poor workmanship and the material should be rejected. This precaution should be taken before it is set in place.

In specifying slate blackboard, it should be clearly stated that the boards shall be $\frac{1}{4}''$ to $\frac{3}{8}''$ thick, in true planes, out of wind, and the exposed surfaces hand-shaved or rubbed to a smooth velvet finish, all abutting edges to be ground and straight so as to make a paper edge joint when set. After setting, all uneven joints should be rubbed until the surfaces are in the same plane. This can be accomplished by insisting on good setting and workmanship in the installation. Better settings are accomplished if the slate is backed with a stiff solid backing such as wood sheathing. This is true also as to composition boards, for they should be delivered in as long lengths as possible, and unless they have a stiff background they will show springiness and soon separate from the fastenings.

Stock Sizes of Slate. — Slate blackboards are cut and carried in stock, in standard heights only. These

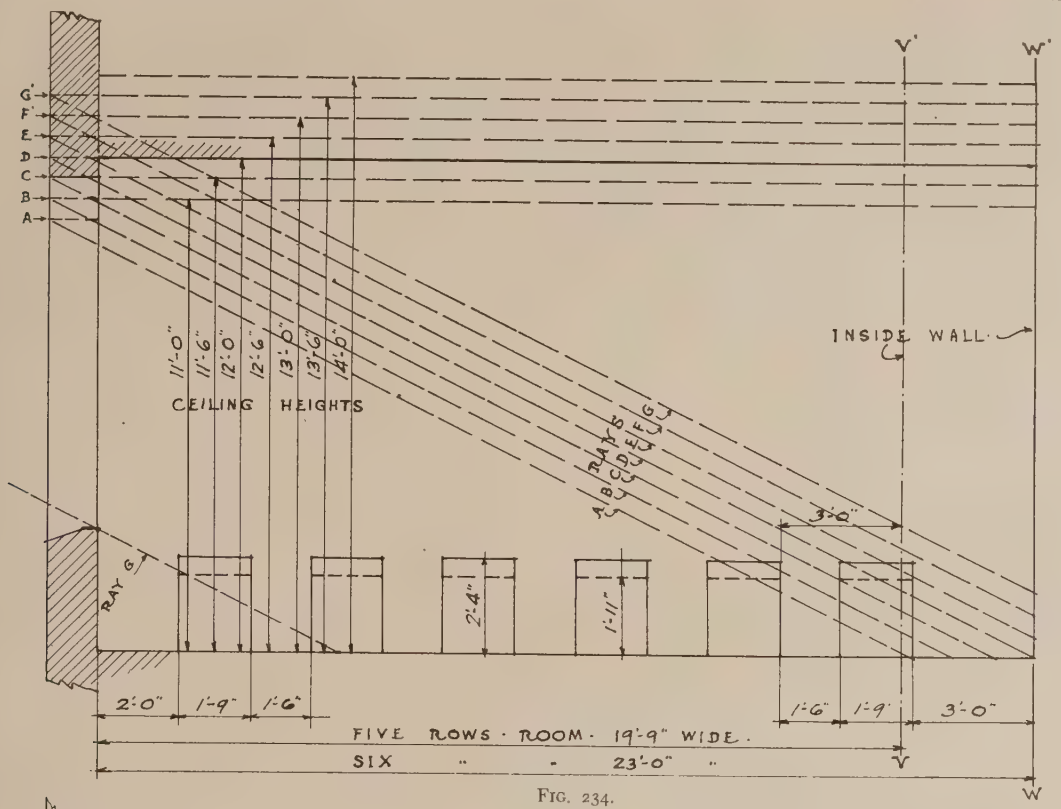


FIG. 234.

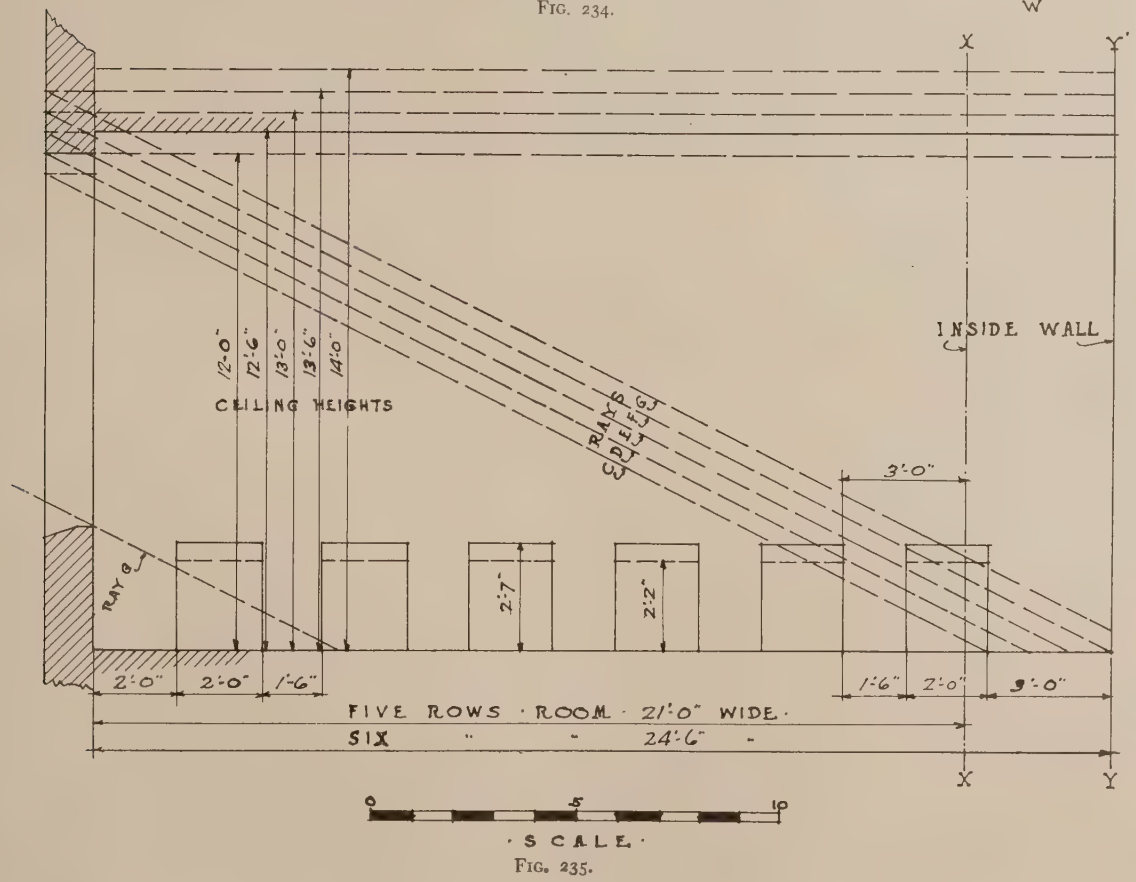


FIG. 235.

Mr. John J. Donovan, Architect.

FIG. 236.—CLASSROOM SHOWING OPEN WINDOWS, CLAWSON SCHOOL, OAKLAND, CALIFORNIA.

standard heights are 3′0″, 3′6″, 4′0″, 4′6″, and 5′0″. This should be kept in mind when writing specifications. Other heights must be cut to order, and as proper blocks are not always available, delays and extra cost will follow. Lengths of slate blackboards range from 3′0″ to about 6′0″.

It is safe to specify that all sections up to 5′6″ shall be in one piece, sections over 5′6″ and up to 11′0″ shall be in two pieces, and so on, using 5′6″ as a measure. Thereby the joints will occur as seldom as the market material will allow. It should be specified further that all blackboards shall be of the best grade of hand-shaved, natural slate, uniformly $\frac{3}{8}$″ thick, free from knots, veins, clay-holes, scale, crossgrain, curl, ribbons, or other defects; finish face on one side only shall be pumiced, rubbed smooth, and of a perfect black uniform color and finish of velvet-like texture. Backs shall be sand-rubbed for correct mounting. All slate shall be set only by experienced mechanics, joints cemented, scraped, and rubbed to form absolutely true, and even flush surfaces. Slate shall be guaranteed not to fade. Good results usually follow.

The details of Figure 231 show the horizontal location of the blackboards in classroom for upper grades of the elementary school, while the details of Figure 232 show more clearly the construction and installation. Type "A" is somewhat similar and less expensive than type "B." On the other hand, type "B" has smaller ledges for the lodgment of dust due to the bed-molds fitting into the angles formed by the wood casings or trim and the vertical walls. In type "B" the chalk rail has a hinged wire screen consisting of number 18 gauge galvanized wire of $\frac{3}{8}$″ mesh, and set in about 6′0″ lengths and hinged every 2′0″ to swing up and back to permit easy cleaning of the chalk rail. Its main purpose is to keep the chalk and erasers free from the chalk dust lying in the trough. It is one of the niceties in keeping with a well-finished room, but may be dispensed with for other more important details. It should be noted that black-

boards should never be placed on the window side of the room.

Height of Chalk-rails. — One of the most important points connected with schoolhouse construction is to have the heights of the chalk-rails correctly established and carefully inspected during the construction of the building. Too much stress cannot be laid to this feature, for the writer has visited schools having the heights entirely out of proportion to the age and size of the pupils using the room. Furthermore, it is really the heights of the chalk-rail from the floor that establish the grade of the room. The grade of any classroom may be changed by changing the furniture, but it is not so simple a matter to raise or lower the chalk-rail and blackboard without going to a great expense in tearing out finished permanent work.

The heights given in Figure 232 are recorded here and are the results of careful observation by both educators and architects. The heights of blackboards above the chalk-rail as shown are recommended because it is useless to install great heights of boards which children cannot reach with comfort and ease. However, conditions may arise, such as proper proportioning of wall spaces, which may require some deviation either one way or the other.

Table No. 1, Blackboard data for classrooms: [1]

Grade	Height of Chalk-Rail above Floor	Height of Blackboard above Chalk-Rail
Kindergarten	2′ 0″	3′ 0″
I and II	2′ 2″	3′ 0″
III and IV	2′ 4″	3′ 0″
V and VI	2′ 6″	3′ 6″
VII and VIII	2′ 8″	3′ 6″
High School	3′ 0″	4′ 0″

Tacking Strips. — It should be noted that the wall or hanging rail above the blackboard as shown in Figure 232 contains cork strips inserted in the rail and serves for tacking papers, drawings, etc. This extends around the room and is exceedingly valuable to the teacher. Credit should be given Mr. Floyd A. Naramore, Architect for the Board of Education, School District No. 1, Portland, Oregon, for this suggestion. The writer formerly used a concealed wire for such hangings, but believes the tacking device is superior. In Boston, where blackboards are not placed, the walls are covered with burlap and a picture mold is installed at the height of the top rail of blackboard, which serves for hanging drawings and pictures at this height. There is also a picture molding near the ceiling.

The blackboards at the front of the room should have the chalk-rail not less than 3′0″ above the floor so that the teacher's writing may be visible from all parts of the room, and above the chalk-rail the board should extend to the door height, which is about 4′0″ above the chalk-rail.

Reach of Pupils. — The following table was compiled after a series of tests made in the Adams Cosmopolitan School, San Francisco:

Grade	Height Tallest Pupil Can Reach to Write	Height Shortest Pupil Can Reach to Write	Lowest Point without Stooping Tallest Pupil Can Write	Lowest Point without Stooping Shortest Pupil Can Write
VIII	6′ 4″	5′ 11″	3′ 0″	2′ 8″
VII	6′ 4″	5′ 8″	2′ 8″	2′ 8″
VI	6′ 0″	5′ 6″	3′ 2″	3′ 4″
V	6′ 0″	5′ 1″	2′ 8″	2′ 10″
IV	6′ 0″	4′ 9″	3′ 3″	2′ 6″
III	5′ 7½″	4′ 8″	2′ 11″	2′ 9″
II	5′ 6″	4′ 5″	3′ 0″	2′ 9″
I	5′ 0″	4′ 0″	2′ 9″	2′ 8″

General Notes. — If the fundamental factors of classroom construction, such as the size, height, and lighting, are correctly fixed, the interior finish and appointments are matters which the experienced, true-visioned architect will bring to a state of completion that will give pleasure and satisfaction. It is the taste, skill, knowledge of material, and experience of such an architect which immediately mark and elevate his work above that of the indifferent practitioner. It costs so little more, and often so much less, to perform and execute good work that it behooves those responsible for such public work as schoolhouses to carefully weigh this consideration. The value of good planning, coordinating of parts, careful study of requirements, and the labor of preliminary research may go for naught if the finished work does not show care and study in the selection of materials, refinement in details, and consideration in the color schemes of the rooms.

How often are the good features of any piece of work lost sight of, or thrown into the background, by a crude and coarse treatment of that which first attracts attention, namely, the exposed finish work! There is almost as much distinction between the finished work of the

[1] Dr. Dressler, in his *American School Houses*, recommends the chalk-rail be placed for grades I and II, 25″; III and IV, 27″; V and VI, 30″; VII and VIII, 32″; and for high school classes, 40″; and that the width of board above the chalk-rail be for grades I and III, 28″; IV and V, 32″; VI to VIII, 36″; and for high school classes, 40″.

The Boston School House Commission require the following: chalk-rail height from floor — Kindergarten, 2′ 2″; grade IV, 2′ 4″ to 2′ 6″; grades V to VIII, 2′ 8″; behind the teacher and on the long side the same; and that boards above chalk-rail shall be 4′ 0″. Also that blackboard shall be ¼″ thick. At the rear of the room, instead of blackboards, soft wood sheathing is used with cork carpet attached to it, extending from the base to the molding at top of blackboards.

skillful architect and of the untrained careless man as one finds in the work of the master artisan and the apprentice. And it is with that thought in mind that the remaining notes on the classroom are offered. Some of the recommendations may be improved upon, and most likely will be, as new devices are discovered and improvements are developed in the various building trades.

It is well to avoid projecting ledges and dust catchers wherever possible. Of necessity there will be a certain amount of trim, such as casings, floor base, picture moldings, etc., but schoolrooms should be finished similar to the interiors of hospitals. The greatly increasing demand for schools and increased requirements in schools of to-day over those of only a few years past will not permit of the far-reaching sanitary treatment of hospitals, because of cost, but in so far as it is compatible with the available money, that should be the objective.

Floors. — Whenever the seats and desks are fixed or fastened to the floors, it generally follows that wood is the material to use for flooring, although it is possible to adopt the awkward method of fastening desks to wood runners. Sometimes the finish of floors is battleship linoleum over cement or concrete, but since this is generally too expensive and used only for exceptional cases, it does not invite exhaustive discussion.

Oak, likewise, is too expensive for general use for classroom floors, and in most cases the builder is held down to the use of maple and some of the other cheaper woods, such as Douglas fir (Oregon pine) in the West and yellow pine in the East and South. Maple is so superior for flooring that, like slate blackboards, it should be used whenever the funds at hand will permit. Boards of education should take these points into consideration before finally determining upon the school building appropriation, in order that there may be sufficient funds to handle the work properly and with the lowest cost later for repairs and maintenance.

It is only in the most cheaply constructed buildings that double floors would not be installed; and under no circumstance should a single thickness of flooring be used for any floor, and particularly for the first floor, on account of dampness and stagnant ground odors rising from below. Likewise, the noises from above make it mandatory that double floors and deafening be used above the first floor. What is offered here is of course applicable to floors of joist construction. Where fireproof floor construction is installed, such as reënforced concrete or fireproof tile arches between steel beams with sleepers for nailing the under floor, the conditions are entirely different and more favorable. Before sleepers are set, they should be immersed in a wood preservative, allowed to absorb to the fullest capillary extent, and then dried before being set in place to receive the concrete fill and rough or finish flooring. If this precaution is not taken, dry rot is apt to set in, causing no end of expense and inconvenience. In order that deafening may be effective, the finish floor should be laid so that it "floats" on $2'' \times 2''$, or better $2'' \times 3''$, wood strips laid and occasionally tacked to the under floor. All deafening should extend upward back of the wall base at least $4''$.

There are a few good floor deafeners or sound insulators on the market, any one of which, if used in sufficient quantity and correctly applied according to the manufacturer's directions, will answer the purpose. All finish floors should be tongued and grooved, blind-nailed, and top-nailed at end joints where necessary, thoroughly sanded by a sanding machine, and hand-scraped and sandpapered near the baseboards where it is difficult to run the sanding machine.

Thresholds, door saddles, or carpet strips as they are often called, should not be used between rooms. Whenever the direction of the flooring changes or there is a change in flooring material, such as wood against cement, marble, or linoleum, the finish floor levels should be carefully adjusted and a tight filler strip of the proper material, either marble, wood, or cement, should be inserted between the jambs and at the floor level.

Interior Mill Work or Trim. — It has been previously stated that the interiors of classrooms should approach the interiors of modern hospitals in sanitary moldings and finish. However, a certain amount of trim is necessary, such as floor bases, chalk-rails, blackboard casings, hanging rails, and picture moldings. These moldings, casings, and rails should be as simple in design as possible and all ledges should be avoided by the use of rounded or coved bed molds. Type A, figure 232, shows a good example of a very simple treatment in larger detail of the interiors of figure 231. Type B of figure 232 is a more complete finish, as the angle or bed moldings are used throughout.

One of the problems submitted to the writer a few years ago was to find a wall material which would take the wear and tear of hard usage for the wall space between the top of the floor base and the under side of the chalk-rail. In the schools visited, especially in the lower grades, which had been in use from six to eight years, we found the plaster walls of this space much damaged, and this damage was more pronounced in appearance in many of the schools when the plaster walls were covered with burlap or heavy canvas, as the covering was torn.

We decided upon the use of built-up veneer panels of the kind of wood used for the interior finish, which was mostly Douglas fir. Upon recent examination, the

Mr. John J. Donovan and Mr. John Galen Howard, Associated Architects.

FIG. 237. — OPEN WINDOWS IN PATIO EMERSON SCHOOL, OAKLAND, CALIFORNIA.

walls were found to be in splendid condition. This is the section of the room which receives the worst kind of wear, evidently from the children's feet and knees. Somehow or other, repair and maintenance of school buildings is given less attention than any other class of public or semi-public buildings, and no buildings except factories are subject to as much use and abuse as school buildings. Therefore, it behooves boards of education to build as permanently with good lasting materials as conditions will permit.

It is not every appropriation that will permit the use of oak as an interior wood finish; but oak, or a similar hardwood, should be the selection, as it gives the most pleasing appearance and adapts itself to almost any color scheme for the room. Furthermore, it is most durable, least susceptible to damage by dents, and may be easily refinished. However, the number of school-houses trimmed in oak is relatively small compared to the number finished in other woods, and we must treat with the conditions that prevail. In the West the most commonly used wood is Douglas fir, known as Oregon pine. It is a close grain wood and very easy to work; is subject to some shrinkage, and therefore the wood should be thoroughly seasoned and kiln-dried. Also the joinery and workmanship should be of high grade. The Eastern and Central states have a greater variety of woods to select from whenever oak is found to be outside the pale of price. Ash, birch, chestnut, white pine, and southern pine are woods adaptable for interior finish.

The day may not be far distant when it will be economical to use metal trim for interior finish. At present, however, it is beyond the reach except only in unusual cases, such as in the many-storied schools of New York City, where its use is mainly for fireproof purposes. It is ideally sanitary, and with the baked enamel finish usually applied at the factory the durability is almost beyond measure.

Doors. — At this age of progress it seems hardly necessary to repeat that all doors in school buildings should open outward from the room. While there is not as great danger from doors opening into a classroom as there is from the exterior doors of the building at the entrance and exits, yet the principle should be followed throughout and without exception. Also there should be but one door to a classroom, as that one means of exit gives the teacher complete control over the pupils in case of fire or alarm. With two doors to a room sometimes an excitable or unruly pupil might dash out of the room and possibly start a panic which could easily cause a tragic loss of life.

Classroom doors should be at least 3′ 4″ in width and the usual height is 7′ 0″. The flush type of door without any panels or moldings is most desirable. They

are built up with a center core, and layers of veneer are applied to the core, giving a smooth even finish.

School authorities differ regarding the use of glass in the upper part of the classroom door, some objecting to the absence of privacy in the room and stressing the fact that the passing of teachers and students in the corridors is distracting to the pupils and teacher within. On the other hand, the writer has found that the glass panels, if divided into reasonably small panes, meet with high favor. Considerable light is transmitted into the corridors, and it is always possible to use ground or obscure glass to obviate any distraction from the corridor.

The door should always be fitted with a lock which never permits the door to be locked to those within the room. This applies to all doors of a school building. There are inexpensive locks on the market that have this feature. The door may be locked from without to prevent pilfering and vandalism, but never from within. Furthermore, the door should be hung to open the full 180 degrees and have a doorholder consisting of a brass socket set in the bottom of the door which fits into a small round brass tongue about $\frac{1}{2}''$ in diameter and set about $\frac{1}{4}''$ above the finish floor of the corridor. Door checks to classroom doors are a nuisance and altogether unnecessary.

Transoms. — The use of transoms in classrooms has been much debated. But experience and observation lead the writer to heartily recommend their use. The demand for more fresh air and freer circulation of air when the ventilating system is not functioning brought about their adoption in groups. When placed near the ceiling opposite the windows, a circulation of air in the room is always possible, since there is generally a difference of temperature between the outside of the building and the corridor side of the room. They are particularly adaptable to one-story schools with open porches, and have been found useful for cross-ventilation of classrooms on each side of corridors. It is always possible to substitute wood panels for the glass if ill effects are found due to cross lighting, but the latter does not occur when the transoms are placed close to the ceiling. Usually the transoms are about $3'\ 0''$ wide by about $2'\ 0''$ high and are hinged and suspended by chains when open. Whenever they are installed, the wall below should be flared or sloped so that any dust lodging there may be easily seen and removed.

Plaster. — Were it not for the bad acoustics so commonly found in the classrooms of our fireproof school buildings this subject might very well be omitted, for there is no intention to include here a treatise on building construction. Modern rapid construction and related conditions brought into practice the use of what is known as hard wall or gypsum plaster, which is prepared before delivery to the buildings and is ready for immediate use by simply adding sand and water. The necessity to make buildings as nearly fireproof as possible developed the metal stud and metal lath. The use of the two materials, metal laths and hard wall plaster for wall surfaces, brought about a harder and denser surface than that of the wood lath and lime mortar. This plaster absorbs less sound waves set in motion by the voice, and reflects the waves, reverberating them through the room. With maple flooring, metal desks with hardwood tops, slate blackboards, the walls and ceilings of metal lath, and hard wall plaster, together with the window glass, the children and their clothing are the only substances remaining to raise the coefficient of absorption of the sound waves in the room. The writer has built such classrooms under fixed building laws and knows whereof he speaks. It is for the peace of mind of both teacher and pupil that these facts are here set forth.

The plastering materials most favorable for good acoustics in a classroom are wood lath and lime mortar gauged with Keene's cement; the next least unfavorable are the terra cotta or burnt clay blocks and lime mortar, and the next to that are the metal lath and lime mortar, and the most unfavorable are the metal lath and hard wall plaster.

All finish plaster work should be troweled to a smooth even finish with a steel trowel. Never should the surface receive a sand finish.

It is not uncommon for a shrewd old plasterer to suggest the sand finish, as it means less labor for him, and speedier results. But the sand finish is a catch-all for the fine particles of dust, to say nothing of germs, bugs, and what not. The writer heartily urges the smooth finish for the health of the occupants of the room, a subject which will be further discussed under "Painting."

Canvas. — In an elementary school building, the walls from the top of the blackboard to the floor receive hard usage, and the wear and tear of these surfaces have brought about the use of burlap or canvas on all plaster surfaces from the floor base to the top wall hanging rail except in such places as under the chalk-rail, previously described. Canvas should be what is known as "Oil Canvas," and be thoroughly sized with strong glue, sizing always to be applied before the canvas is placed in position. The canvas should be hung in perpendicular strips as with wall paper wherever the height to be covered is greater than the width of the canvas. It should be well pasted on the back with strong fresh glue and special care taken to make close, neat butt joints properly rolled down. Immediately after each

stretch is finished sponge off with fresh clean water to remove all glue from the outside surface. All canvas work should call for a guarantee against peeling, blistering or other defects of material or workmanship for at least one year after completion. After the canvas has dried out it should receive at least two good coats of lead and oil as a finish.

In specifying canvas, it is very important that only a high grade material be called for and used. The brand used should be one especially prepared for wall covering, and one which does not shrink or permit the glue to ooze through the weave, and which can be laid without the joints showing. The unprepared canvas will shrink and cause no end of bother, and never can be made satisfactory.

Painting. — The color schemes for classrooms should be simple and of good taste, and the reason for this is quite evident. In the first place, with a black band of blackboard, the top of which cuts the height of the room in two, with the many-colored desk tops and seats and with desk supports of sharp color, usually black, there is very little chance to get away from the simplest of selection in color, as the restrictions have been rightly imposed by the requirements of utility attached to the problem. Occasionally we hear and read of color schemes for classrooms by some one who has spent but a little while within one, and who overlooks physical conditions that prohibit anything apart from a simple light treatment of both walls and ceiling.

Who has not been in school buildings where either the colorist or the painter has attempted to reproduce the greens, blues, reds, and purples of nature on the walls of rooms for study, until they seemed to howl with violence? Time and again one wonders what prompted the impulse. There are many such examples of poor taste, and they are not rare except in vigor. What can we expect of children who have to spend at least one-tenth of their life within rooms that either excite or depress?

The question of color scheme is extremely simple. First, the ceilings and walls should reflect as much diffused light as possible. Therefore the ceiling should be as close as possible to the white shade without having the dead white effect. The egg-shell white is not displeasing, and it should be carried down to the top of the picture molding, which is usually placed close to the ceiling. Below that, light buffs, light grays, or any of the light, soft, pleasing hues which will harmonize with the wood stains, keeping them, however, light and flat, will give satisfactory results. Whenever burlap is used the same care should be exercised to keep the tones soft. Tans are good colors for this surface.

Tints produce more pleasing and softer effects than paints, although many of the washable wall paints now on the market give pleasing flat tones. The ceilings may be tinted, but whenever the money available will permit the use of flat washable wall paints, these should be adopted. For with three good coats of a reputable make, it is possible later to wash and clean the walls with soap and water. The plaster finish must be smooth and not sanded. For first-class work the ceiling should receive two coats of tinting in addition to the coat of sizing; likewise the walls, if tinted. But if paint is used for either walls or ceilings, three coats are necessary to produce a satisfactory result.

Seldom is the finished woodwork painted. It should be stained, shellacked and varnished and brought to a flat tone. The grain of the wood is enhanced by such treatment. And this is a matter on which the purchasing agent of the Board of Education should confer with the architect in the selection of the finish and colors of the school furniture. Many pleasing interiors have been marred by a thoughtless selection of furniture. Nobody with any taste would think of furnishing a home without giving thought to the colors of the rooms and the furniture, in order that quiet and harmony may be the prevailing note throughout.

It is a good thought and well expressed that the proper color schemes for different rooms and different classrooms vary. They should be handled, however, with some thought of the orientation of the room. It should be emphasized that selection of colors receive just as much attention as any other part of the work, for it is equally as important in its effect on the pupils for whom the school is built.

Floor Treatment. — It has long been the practice to oil the floors of classrooms in order to preserve the finish surface and to keep the dust from rising. A number of practical men have been consulted who have had wide experience in the use of materials for this purpose, and the best of the information obtained is given below.

Floor Oiling. — The floors should be first thoroughly cleaned with hot water and a cleansing powder, using scrubbing brushes to remove all dirt, dust, and foreign substances, then allowed to dry thoroughly before applying the oil dressing. In re-oiling floors this cleansing process should be strictly followed in order to preserve the natural color of the wood and to defer as long as possible the darkening or turning black of the floor.

After the floor has been washed and allowed to dry, the oil should be applied with a mop and thoroughly mopped into the wood pores and allowed to penetrate thoroughly into the grain. After twenty-four hours the floor should be remopped with a dry mop which has

been saturated with the oil and allowed to thoroughly dry, taking up any superfluous oil that may not have penetrated into the wood. This will give the floors a polish and prevent to a great extent soiling of the girl pupils' dresses. This work should be done about a week before the new building is accepted and during summer vacations in school buildings already in use. Once a year is generally considered sufficient for oiling floors completely and twice a year for the aisles between desks, but it is far better to make a thorough job of it twice a year. If the oiling is well done, it is then only necessary for the janitor to sweep the floors once a day with a long-handled 12″ Russian bristle hair floor sweeper.

The use of sprinkled sawdust in rooms with fixed desks should be discouraged, as it is almost impossible to prevent particles getting in around the floor flanges of desks and seats and creating unsanitary conditions. Cleaning floors by the vacuum process is not successful where desks are fixed or screwed to the floor, as it is difficult for the janitor to handle the hose and tools in and around the desk supports. It takes janitors longer and the work is not efficiently done as when done by the sweeper, particularly over oiled floors. The vacuum cleaner is desirable, however, for cleaning the blackboard erasers and the chalk rails. Chalk dust is very injurious to the lungs.

When there is objection to the use of floor oils for floor finishes the following is a comprehensive description of a treatment which gives a hard durable finish. Different woods, of necessity, call for special care. Every kind or all kinds will not accept the same treatment. The treatment given should be that which the nature of the wood requires.

Floor Dressings. — The first thing to do with the newly laid floor after the surface has been sanded is to fill the pores of the wood with a prepared paste wood-filler made, for best results, from a combination of silica, or silex (quartz rock), linseed oil, Japan drier, thinned ready for application to the floor surface with either spirits of turpentine or petroleum naphtha. This prepares for a natural wood effect. If the wood is to be stained the stain should always be applied *before* the filler is put into the pores of the wood. This filled surface when it has hardened is sandpapered smooth and presents an even, uniform surface that will indefinitely prolong the life of the wood, and requires much less care and expense than an unfilled surface, and also requires less material for subsequent finishes of whatever kind employed. All stairway treads should receive like treatment when made of wood. The wood having open pores and demanding such treatment as stated are oak, ash, elm, cedar, maple, gum, and Oregon pine (Douglas fir), all of which are greatly improved by this treatment. The more porous the wood the more need of filler. But porous wood, well filled, presents a relatively hard surface.

Floors of halls of assembly, baths, gymnasiums, schools, churches, and public buildings give splendid service when, after they have been properly filled, they are given a first coating of a mixture of equal parts of raw linseed oil and petroleum naphtha. Allow sufficient time for the wood to absorb all it will and then remove surplus oil from the surface to prevent any tackiness of the material. An occasional cleansing of the floors and a repetition of the process of oiling as above stated will not only preserve the floor but keep it in an acceptable condition and appearance.

There are other ways of finishing floors made of wood where they are used for banquet and dance purposes. The filled surface can be given an application of prepared floor wax and thoroughly polished or burnished with a weighted floor-polishing brush, or a coating of prepared dancing wax can be spread over the filled surface, letting the feet of the dancers do the polishing and finish. Another way is to apply one or more coats of a good quality of floor varnish (*not shellac*) over the filled floor surface if durability or service is desired. But there is one thing to be borne in mind in using varnish as a finish on floors. Keeping it in repair demands more expense and care than an oil or wax finish, as it cannot well be patched when worn in places of more or less constant use. The least durable of all floor finishes is the painted floor. Like the varnished surface, it is difficult to keep in repair without going over the whole surface.

Linoleum. — Inlaid or battleship linoleum floor covering when newly laid should never be varnished to preserve or beautify it. But if when cleansed it is given an occasional going-over with a cloth or mop slightly saturated with a solution of equal parts of raw linseed oil and either turpentine or petroleum naphtha, being careful to leave no surplus oil to become tacky, it will be beautified and its life prolonged. This does not apply to the cheaper class of stamped linoleum floor coverings.

Linseed Oil and Turpentine. — Another simple but effective treatment is to apply one coat of pure raw linseed oil and 25 per cent of turpentine and a small amount of Japan drier, thoroughly mixed and applied hot. Although this is not a dust allayer, it makes a very pleasing floor finish.

Location of Air Registers. — When a ventilating system is properly laid out by a competent heating and ventilating engineer, there should be little or no occasion for the misplacement of air supply and exhaust vent openings. On the other hand, the principle of complete circulation of the air is often abused, and it

may not be always convenient to obtain the services of an engineer. Therefore, a description of the classroom which disregarded this point would not be complete.

In a room 13′ 0″ high the center of the supply opening should be about 9′ 0″ above the floor, and its location gives best results when the air in its travels makes a complete circuit of the room. In classrooms of type Figure 219, the proper location is back of the teacher's desk. Then the air will pass out into the room and gradually force its way back under the wardrobe doors, and up to the vent in the ceiling of the wardrobes. The supply and exhaust should always be at the same side or same end and never in opposite walls. Air, like water or electricity, will take the line of least resistance when under pressure. For effective ventilation the air should be forced to circulate into all parts of the room.

The location of the exhaust in figure 221 should be observed. Here the supply is located at one end of the wall side, and the air exhausts under the wardrobe doors and up through the vent in the ceiling of the wardrobe end furthest removed from the location of the supply. The course the air must take in its movement will include every seat in the room.

Windows.[1] — The demand for open air classrooms led the writer in 1912 to devise a window that would make practically every classroom an open air room at will. For he thought that if it is desirable to have open air rooms for tubercular or anæmic children it is equally desirable to preserve the health of healthy children. Figures 236 and 237 are fairly good photographs of the results attained. These window sash operate on a small roller, and by means of thin galvanized metal arms may turn through an angle of 180 degrees. The top of the sash moves in a vertical plane, while the bottom of the sash moves outward and upward.

The problem of shading the sun from the room and preserving the full width of opening was solved by hanging a separate shade on each sash at the bottom, and placing eyelets in the shade slat; the latter travels along fine galvanized wires and prevents the shade from flapping and tearing. Thus the sash may be completely covered by the shade, and by adjusting the sashes at the proper angles each sash shades the open space below.

Shades. — Window shades in classrooms should never be opaque, but rather translucent. In laboratories there are occasions for opaque shades, which are discussed under the science group, but in the classroom they ought to be banished entirely. The shades are found to be more satisfactory when the oiled shade cloth is of rough surface or of the light cotton duck or canvas containing no starch, paint or filler, and dyed to the color desired. Usually the tans or grays give better results, as they harmonize with the interior colors of the room and generally with the exteriors. The green shades are too strong in contrast with the surrounding colors and tend to darken the room too much. Besides, they vitiate the outside color scheme. Many well-designed exteriors have been spoiled by the use of dark shades.

Hanging of shades is so well understood that it seems hardly necessary to say more than a word regarding it. With double-hung windows there should be two sets of shades with each masonry opening, and the rollers should be placed at the meeting rail, with the lower shade roller above the roller for the upper shade and arranged so the shade cloth pulls down and behind the upper shade roller. It is decidedly bad practice to suspend shades from the head of double-hung windows, as it prevents operating the shade so as to obtain full advantage of both light and air, and renders it impossible to prevent noisy flapping when the window is open and the wind is blowing. Shades should extend at least one inch beyond the inside edge of the casing or jamb, with the slats one-half inch wider than the shades.

Recently there has been introduced a number of patented adjustable shade fixtures adaptable for use on double-hung windows, and inasmuch as there is room for improvement it is well to reconsider this problem as each new device is submitted.

Venetian Blinds. — Venetian blinds for shades to classroom windows have been frowned upon by school authorities on account of the dust settling and collecting upon the slats, also on account of the horizontal streaks of light reflected into the room, which are particularly bad at the level of the eyes. In the last few years, however, the installations of venetian blinds have become more successful and are very much used, especially where it is desirable to keep the windows open wide during the hot days and at the same time shut out or deflect the sun's rays. The success of these installations is due to the use of a wider slat which, when tilted at the proper angle, greatly obviates the horizontal streaks and reflects the sun's rays to the white ceiling, giving a diffused light to the room. Another reason is due to the use of a wood of light color which, if treated in the natural, causes a sense of diffusion of the light from that part of the room. Venetian blinds are better adapted to rooms for laboratories, offices, cooking, typewriting, and similar rooms, where it is possible to move about, rather than to classrooms where the student is confined to a fixed position.

The best materials for venetian blinds are cedar, yellow pine, and redwood. Cedar is by far the best because of its toughness. Moreover the grain enables it to take a good light natural finish which will reflect the maximum amount of light, and it is much easier to keep

[1] The Universal Window.

clean than any other finish. There are several styles, but the top roll blind is best for school work. This operates so as to insure the bottom of the blind being raised evenly. The blinds should be made so that the slats tilt easily and positively to give control over the sunlight entering the room.

The advantage gained by the use of venetian blinds is that in localities of intense sunlight the south and west exposures need not be avoided, making possible more economic planning, especially if the architect is confronted with the problem of east light only for classrooms.

CHAPTER XIII

KINDERGARTEN

By John J. Donovan, B.S., *Architect*, A.I.A.

I. General Remarks. II. Exposure. III. Size. IV. Furnishings. V. Subjects Taught. (1) Music. (2) Language. (3) Literature. (4) Rhythm. (5) Games. (6) Nature Study. (7) Manual Training. (8) Socialization.

General Remarks. — There is very little opportunity in the elementary school for the architect to depart from the uniform fixed requirements in planning classrooms, but when he comes to the kindergarten there is every incentive and great possibility for freedom to do something out of the ordinary and the conventional. In its broadest sense, the kindergarten is a room more for supervised play than for study, with its dances, games, singing, and its beautiful make-believes. It is where the child receives its first impression of school life, and the room and environment should be made as attractive and interesting as possible, so that the little ones may get as much joy out of their first school year as comfortable and pleasing quarters may provide. Therefore, the architect should feel free to exercise his taste and imagination in making this room a little wonderland of childhood.

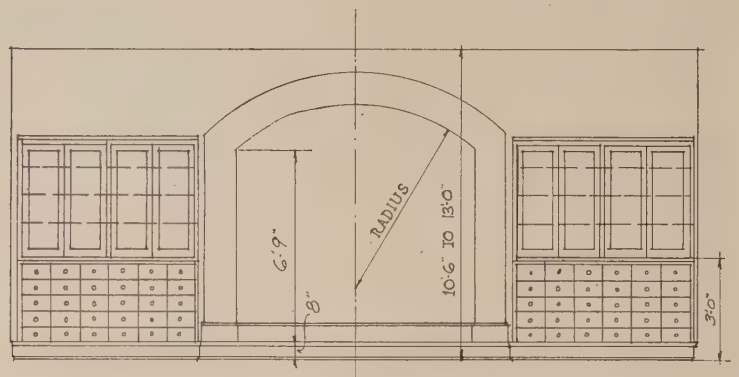
Exposure. — Its exposure should be the southeast corner of the building, on the ground floor, for warmth and cheer. That location makes it possible to have separate playgrounds, a pergola, covered porch or sun room just off the main room, and a small garden where the children may have practical lessons in nature study. The garden should be large enough to provide a small plot for each child. Mural decorations or paintings of children at play, animals, allegorical subjects and nursery rhymes told by good paintings, applied to the frieze or wall spaces above the door headline or above the blackboard space, if well done, will be worth the expense for the children's mental welfare and for the pleasure and happiness they will give.

Size. — In size, the room should be equivalent to one and one-half or two classrooms. It is a room which might be described as having elastic dimensions, as there are no fixed seats or desks. Where there is an alcove for sand tables, piano, racks, etc., a room 24′×40′ will give ample space, especially if there is an outdoor porch or sun room. Figure 238 shows a plan of the kindergarten in the Clawson School, Oakland, California, which admirably lent itself to the general plan of the school.

This plan provides for fifty children divided into two classes, a morning and an afternoon class. Figure 239 is a view of the interior of the room, showing the fireplace around which the children gather at Hallowe'en and Thanksgiving to pop corn, and where at Christmas time stockings are hung and filled. On dark and rainy days it is pleasant and cheerful to have a log fire and to gather around it for stories and tales which linger long in the child's memory and engender an affection for school hours. The cases and drawers on either side of the small stage are for the children's work and material. There should be drawers 10 inches wide, 12 inches deep, and 6 inches high for each child, and the top drawer should not be more than 3′ 0″ above the floor, so each child may take out and replace his own work. The cases above the drawers are for the teacher's use.

A circle 16′ 0″ in diameter is often painted on the floor with an allowance of 4′ 0″ outside of that for clear space for many of the games. The alcove, about 15′ 0″×11′ 0″, is a convenient place for the sandbox and the piano, and gives more freedom to the main room. Juvenile plumbing fixtures, such as the water-closet 10 inches high and the regular chinaware lavatory, are necessary and should be in a room adjacent to the main room. One such toilet room is sufficient for children of kindergarten age. Special care should be taken to place the wardrobe hooks and rails at a height easily reached by the children. The lower rail should be not over 30 inches from the floor. (See Figure 232, p. 266.)

Figure 240 shows the covered porch at the Clawson School. It is adjacent to the kindergarten playground, and here the children go to play during pleasant weather and to do carpenter work in the making of doll houses, wagons, boxes, houses for pets, etc. Discarded pieces of lumber from the manual-training shop find ready use in the kindergarten. The porch could easily be inclosed

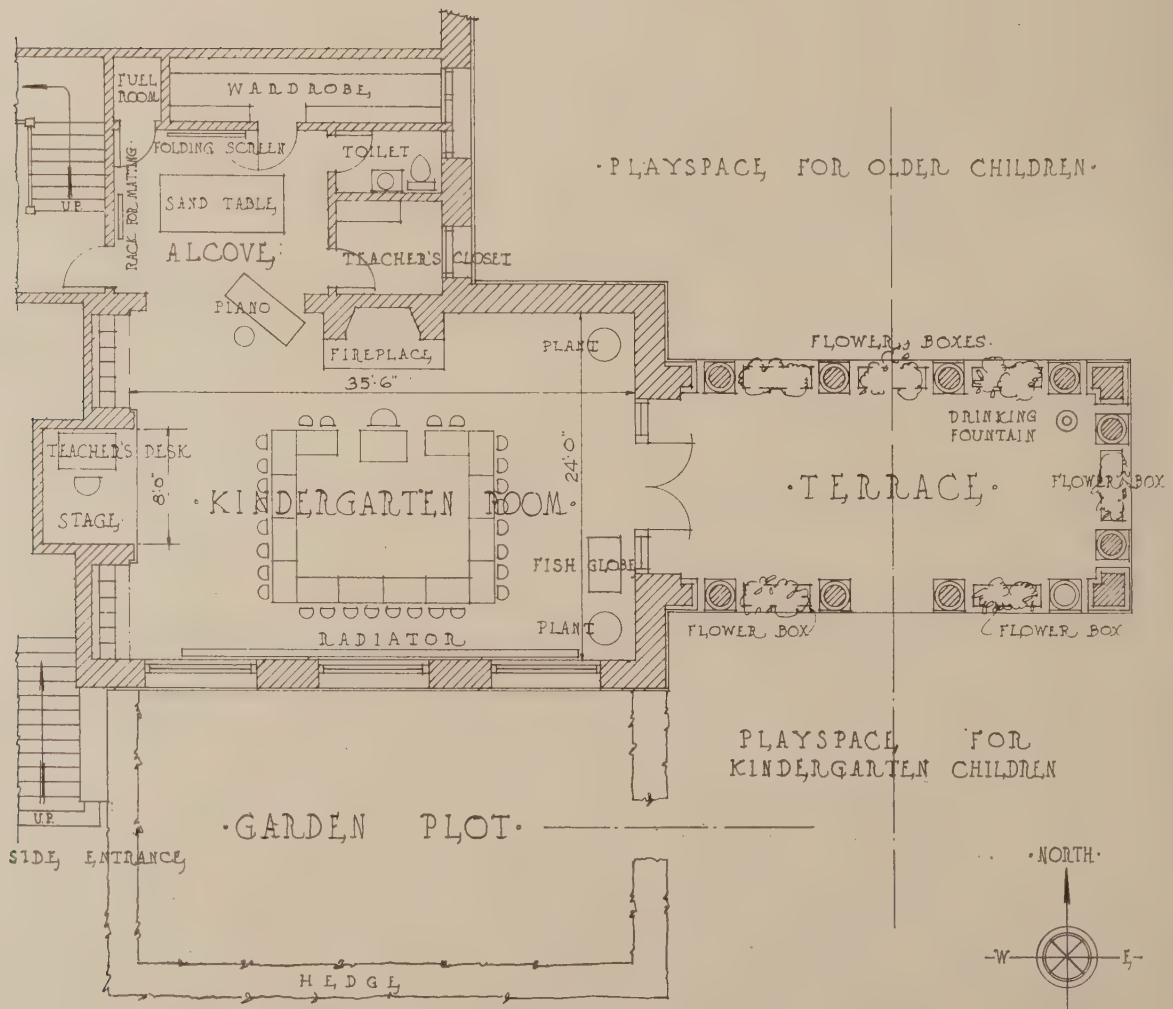


ELEVATION TOWARDS STAGE IN KINDERGARTEN.

DRAWERS 10"X12"X6" DEEP (BELOW)
CABINET GLASS DOORS 3 ADJ. SHELVES.

LIST OF EQUIPMENT.

7 TABLES 36"X20"X18" HIGH.
7 TABLES 36"X20"X20" "
14 CHAIRS 10" "
14 " 12" "
1 CHAIR 15" "
1 RACK FOR 30 MATTING RUGS (1YD. SQ.)
1 DOLL HOUSE, 4 ROOMS, 3 SQ. FT. EACH.
1 FOLDING BURLAP SCREEN EACH LEAF 4'0" HIGH BY 5'0" LONG
1 PIANO. 1 FISH GLOBE, PLANTS ETC



PLAN OF KINDERGARTEN ROOM.

FIG. 238.

FIG. 239. — INTERIOR — KINDERGARTEN CLAWSON SCHOOL, OAKLAND, CALIFORNIA. *Mr. John J. Donovan, Architect.*

with removable doors and sash, so that in the winter it might serve as a sun porch. Here is a good place for the sanitary drinking-fountain, placed low enough for the smallest child. The playground should have small slides, several swings and sandboxes and boxes and cages for pets of different kinds. These may be had at very little cost and go to make up the equipment for the day's study and play.

When boards of education are restricted in funds and cannot afford the additional room for the alcove or the porch, Figure 241 is a good example of a room which will very well serve the purpose. This room is 24 feet wide by 45 feet long and should be at least 13 feet high. The drawers and lockers are built into the wall as shown. Apart from the omission of the alcove and the porch there is very little difference between Figure 241 and Figure 238. Figure 238, however, permits opportunity for wider use and activity for kindergarten work.

Furnishings. — The furnishings for the room are as follows:

Piano.
8 tables 36″×20″×18″ high.
8 tables 36″×20″×20″ high.
15 chairs 10″ high.
15 chairs 12″ high.
1 chair 15″ high for teacher.
1 rack large enough for 30 yards of square matting rugs, used by the children when working on the floor.
1 small table for a fish globe.
2 taborets or pedestals for plants.
1 doll house containing four rooms each 3 feet square.
1 folding burlap screen with four leaves, each leaf 5′ 0″ wide by 4′ 0″ high. This is to be used as a portable playhouse.

Picture frames should be arranged with a hinged door in the back in order that pictures may be changed easily.

Subjects Taught. — Some of the things taught in the kindergarten are as follows:

Music. Calls and exercises for proper placement of voice. Songs — both by group and solos.

Languages. Children are given an opportunity to talk and are helped in their choice and use of good English.

Literature. Children receive and learn to appreciate the best in literature when they are given such masterpieces as the Mother Goose Nursery Rhymes and such stories as "The Little Red Hen," "The Three Bears," "The Three Little Pigs," etc.

Rhythm. Children are taught to recognize the difference in the time of music. They learn the difference between music for skipping, marching, galloping, etc.

FIG. 240.—KINDERGARTEN PORCH, CLAWSON SCHOOL, OAKLAND, CALIFORNIA. *Mr. John J. Donovan, Architect.*

They are very soon able to keep perfect time to any kind of music.

Games are a very important part of the kindergarten curriculum. Children of this age love activity, so the simple games with a great deal of activity are chosen, also imitative games. The games are developed usually through suggestions from the children, and are seldom given "ready made." Through the games the children gain physical grace and coördination, rhythm, and best of all, the spirit of true sportsmanship. Some games which are full of activity and are great favorites are: "Stooping Tag," "The Merry-Go-Round" and "The Shoemaker Dance."

Nature Study. Gardening, gathering of seeds, cocoons, etc. Care of pets.

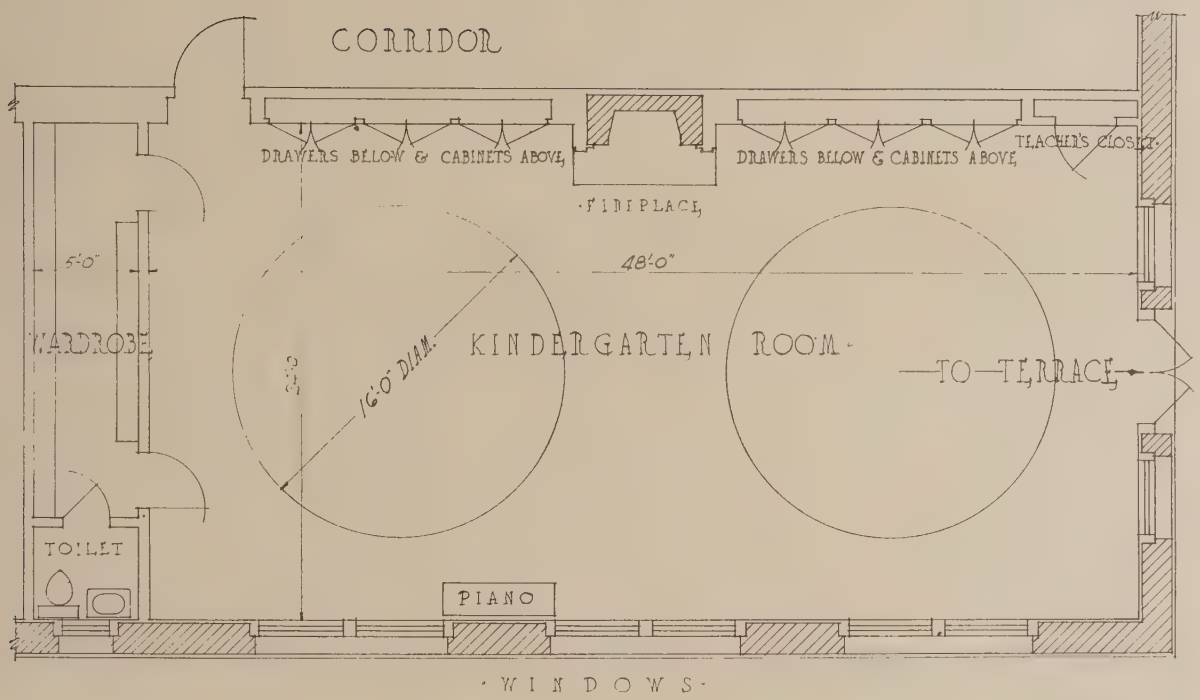
Manual Training. Some of the occupations in the kindergarten are: sewing, weaving, paper folding, paper cutting, drawing, painting, clay modeling, and stringing.

Socia ization is emphasized greatly in the kindergarten and so cultivates the community feeling and thought. All of the children take part and are interested in the building or furnishing of the doll's house, dressing of the doll, planting of the garden, seeds, caring for the fish and the plants.

It can be seen from the above description of the equipment and program of studies that the kindergarten is hardly more than a pleasant room where the child's welfare, deportment and discipline are of more concern than what it is taught, and in consequence of the kindergarten being the first step from home to the care of society, a further plea for attractiveness to the room, its accessory rooms, and adjacent planting and playgrounds is not amiss.

There is no end to the possibilities that the future may have in store for this very elementary grade. The writer is optimistic regarding the future planning and development of the kindergarten.

Referring to Figures 244 and 245, kindergarten rooms executed by Mr. Wm. B. Ittner, Architect, and to Figures 246, 247 A and 247 B, Downers' Grove Kindergarten, by Messrs. Perkins, Fellows and Hamilton, Architects, it will be observed that these gentlemen have struck a high note in the planning and decorative work of these rooms.



ALTERNATE PLAN OF KINDERGARTEN ROOM

0 5' 10' 15'

SCALE.

FIG. 241.

Mr. Wm. Templeton Johnson, Architect.

FIG. 242. — KINDERGARTEN, FRANCIS W. PARKER SCHOOL, SAN DIEGO, CALIFORNIA.

Mr. Edwin M. Gee, Architect.

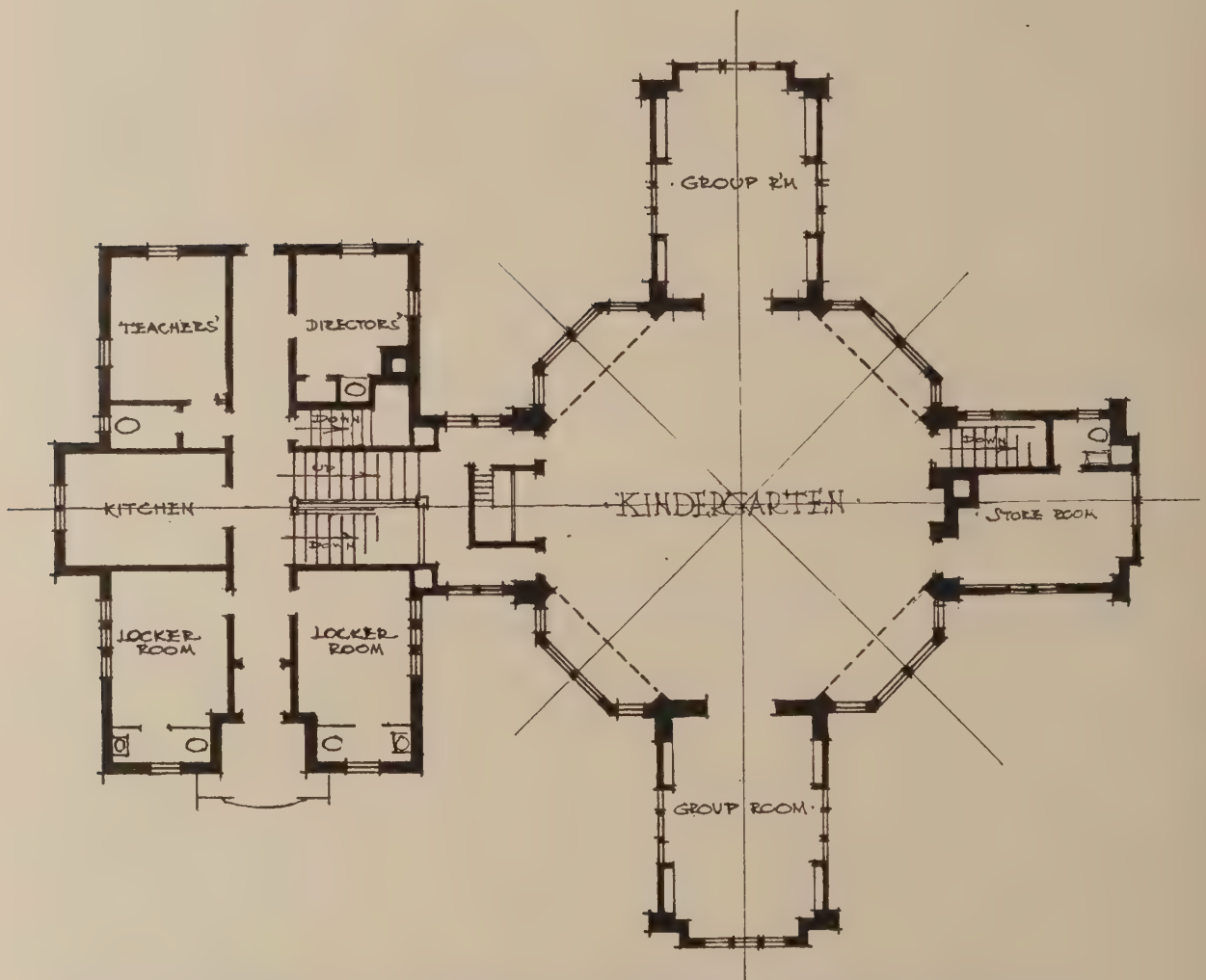
FIG. 243. — KINDERGARTEN, LINCOLN SCHOOL, TOLEDO, OHIO.

Mr. Wm. B. Ittner, Architect.

FIG. 244. — KINDERGARTEN, BRYAN MULLANPHY SCHOOL, ST. LOUIS, MISSOURI.

FIG. 245. — KINDERGARTEN, LACLEDE SCHOOL, ST. LOUIS, MISSOURI.

Mr. Wm. B. Ittner, Architect.



DOWNERS GROVE · KINDERGARTEN ·

· DOWNERS GROVE · ILL ·

· PERKINS · FELLOWS & HAMILTON · ARCHITECTS ·

FIG. 246.

Messrs. Perkins, Fellows & Hamilton, Architects.

FIG. 247 A. — KINDERGARTEN, DOWNER'S GROVE, ILLINOIS.

FIG. 247 B. — KINDERGARTEN, DOWNER'S GROVE, ILLINOIS.

Messrs. Sellons & Pearson, Architects.

FIG. 248. — OPEN-AIR KINDERGARTEN — FRÉMONT SCHOOL, SACRAMENTO, CALIFORNIA.

Messrs. Guilbert & Betelle, Architects.

FIG. 249. — KINDERGARTEN, CLEVELAND SCHOOL, NEWARK, NEW JERSEY.

CHAPTER XIV

THE SCHOOL LIBRARY

By John J. Donovan, B.S., *Architect*, A.I.A.

I. The Importance of the School Library. II. The Location. III. Size. IV. Interior Construction. (1) Stacks. (2) Doors. (3) Flooring. V. Ventilation. VI. Lighting and Illumination. VII. Finish. VIII. Equipment. (1) Shelving. (2) Chairs. (3) Desks. IX. Fireproofing.

The Importance of the School Library.[1] — The school library, in the importance of its relation to the whole school plant, is second to no other department. Indeed, the time is not so far distant when it will serve the secondary school and the community as the college library serves the needs of the university. Like the school itself, it has not yet been fully discovered. Not so long ago, cities and smaller communities reclined in satisfaction upon the fact that their school operated but six hours out of the twenty-four. There was no conception of the intellectual stimulus that comes to the adult long after he has left school, — an activity that has in it possibilities for a more complete development both intellectually and industrially, and which, when the opportunity is offered, brings the adult back to the school for further training that will make him more valuable to himself and the nation. There was no appreciation of the fact that the operation of the school plant between 7.15 in the morning and 9.30 in the evening would offer such an opportunity without appreciable wear and tear to the machinery.

At that time the school library was considered sufficient if it consisted of a single small room with a few shelves containing duplicate text books or a few editions for supplementary reading. The principal or the English teacher supervised the library in conjunction with his other duties. It was considered a duplication of the same function to have a library department directed by a school librarian if the community possessed a public library. The distinct functions of both were not clearly understood, and consequently the other departments of the school advanced more rapidly in personnel and equipment.

To-day it is different. It is generally understood that the public library is an institution endowed for the purpose of providing intellectual enlightenment for the entire community, and that the school library is a department of the school serving the school as the public library serves the community, except in a more intensive and specialized manner. The school library so functions with the school organization that if it is inadequate in size and equipment, or poorly located and administered, the educational efficiency of the school as a whole is greatly impaired. On the other hand, an adequate well-conducted library may offset a number of deficiencies in other departments. The library is of such importance to the school plant that it might be stated as an educational axiom that the prospective value of the student to the state, society in general, and to himself, is largely dependent upon his regard for the library and his ability to make the fullest possible intelligent use of it.

Happily, the tendency is to train students now to use the room and its contents. A letter at hand states that at Rochester, Minnesota, the junior and senior high school students are allowed to enter the library only at the beginning of a period and must remain until the close of that period. By this wise regulation, confusion of movement is avoided and there is afforded at least thirty to thirty-five minutes of absolute quietness. (Figure 250.) It is also stated that as students enter the

[1] In presenting this chapter, the writer feels indebted to the following people for the valuable information contained in their writings on "The School Library":

Miss Irene Warren, Chicago, Ill., through the courtesy of *The American School Board Journal*.
Miss Mary E. Hall, Librarian, Girls' High School, Brooklyn, N.Y.
Mr. Gilbert O. Ward, Cleveland Public Library, Cleveland, Ohio.
Professor C. C. Certain, Cass Technical High School, Detroit, Mich.
Mrs. Elizabeth Madison, Librarian, Oakland High School, Oakland, Cal.
The Library Bureau, for their many illustrations of equipment and interiors.

FIG. 250. — HIGH SCHOOL LIBRARY, ROCHESTER, MINNESOTA.

room, they are required to sign their names in an enrollment book, and the records show that out of a total of 700 students, 350 or 50 per cent of the school use the room daily. This is a gratifying indication of the measure of usefulness and service of this room.[1]

The library should have the same relation to the student as the tool room of the machine shop has to the mechanic. The latter knows that to perform special work, special tools are necessary, and experience has given him judgment in selecting the right equipment to execute accurately the work at hand. In like manner, the student should receive a training in the intelligent and independent use of the library, which knowledge will enable him to find quickly the means of illuminating the way and strengthening his grasp on the problems of education and industry. If he passes through the high school without this training, it is not unlikely he will leave college without it, and as the majority of high school students do not go to college the loss is all the greater to both the state and the individual. To one unaccustomed to the use of a library, the room with its vast number of books is a bewildering maze; but to the trained user, it is a quiet spot where tried friends and wise counselors may be met in valuable association.

It is earnestly recommended by authorities on school libraries that the curriculum of the first year's work should include a thorough course in the use of the library, with directions as to the use of reference books, encyclopedias, dictionaries, works of literature, science, card indexes, etc. This will lead to direct methods for intelligent research and a later saving in time in the use of the college or public libraries.

Location. — The library should be centrally located, so that it may be conveniently and quickly reached by the students from the departments whose use of the room is greatest. Consequently, it should be nearest to the rooms assigned to academic studies, such as history, English, literature, civics, and the sciences. Inasmuch as the library is a special room and generally large, its location and importance should have a decided influence

[1] This system is in use in many other schools, for instance the high schools of Los Angeles, California.

upon the architectural treatment of the plan and elevation. Very often it is the motive for special accent in the exterior design of the building; and if it is well handled in plan, it should be an influential factor in the composition.

Whether it should be on the second floor or on the ground floor, is largely dependent upon the policy of its use. If it is to be used by the pupils only, the second floor because of quietness is by far the more desirable. If its use is to be shared by the public, it should be located so that the community patrons will cause the least interruption of the work of the school and that of the pupils in the library. After weighing the probable advantages to the public, it should be remembered that the room is primarily a school study or reference room under the administration and discipline of the school librarian, and that any outside interference or interruptions will seriously affect the efficiency of the students' use of it. This outweighs any advantage gained by admitting a small percentage of the community to its use. However, if it has a combined purpose, it should be arranged so that the public and the students are completely separated; in order to do this, the room should then be placed on the ground floor, with a separate entrance for the public, and an additional librarian provided to serve them. There is still another very important factor regarding this phase, and that is, the use of the library by the students enrolled in the continuation school. A striking example is that of the Technical High School in Oakland, California. In this institution there are 2000 day students and 4400 continuation students. Of this latter number, there are 1500 who attend the school between the hours of 1 P.M. and 9.30 P.M. daily. About 60, or 4 per cent, of the continuation attendance have occasion to use the library constantly. Also, many arrive at the school before the hour of classroom or laboratory work and sensibly drift into the library instead of waiting in the corridors or outside the building. It is evident from this that the library should be located so that it is also easily accessible from one of the entrances in order that the continuation school students may quickly reach the room without having to add to the congestion of the corridors. Service is the important factor in deciding matters of this kind, and in the construction of a school, it is only after the conditions of policy, arrangement, and equipment, for both present and future needs, have been studied with the librarian that the location of the department should be determined. Furthermore, the library is very rapid in its growth, and wherever located, provision should be made so that logical expansion will always be possible.

Size. — For elementary schools, the library need not be more than about two-thirds the size of the average classroom, as there is very little reference work in this grade of school organization. However, there should be shelving space for about 800 to 1000 books for both the teachers' and older pupils' use for outside reading. Public School 29, Brooklyn, N.Y., designed by Mr. C. B. J. Snyder, Architect, contains a library seating forty pupils, and which communicates with the office of the vice-principal by means of a door at one end of the room and with the adjacent classroom by a folding partition at the other end. (See Figure 251.) The library and adjoining classroom may therefore be thrown into one and used as a study room if so desired. This school has a capacity of 1986 pupils and includes grades from 1A to 9B inclusive, which is equivalent in number to the grades of the elementary and junior high schools.

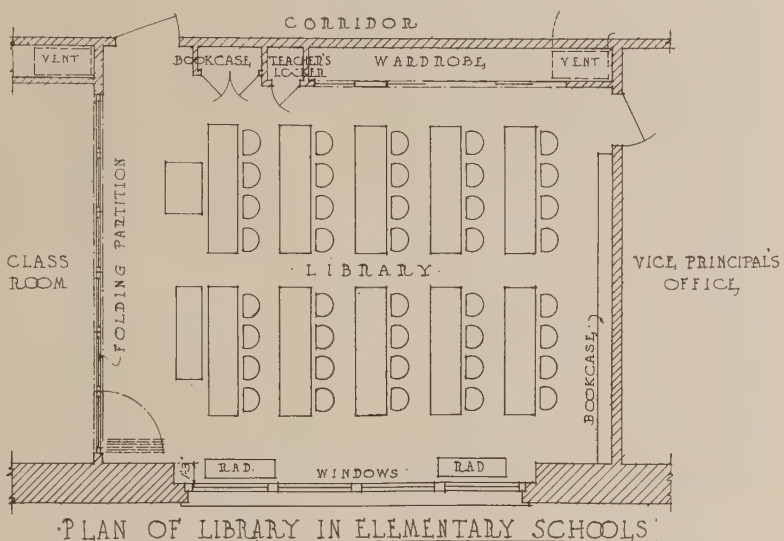


FIG. 251.

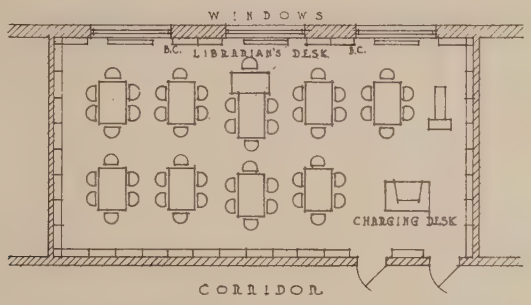
For the intermediate or junior high school, the library assumes more importance and should offer space to seat at least 6 per cent of the school enrollment, as the majority of the pupils will not advance to the regular high school. (See Figure 252.) It is at this time that pupils should receive a training in the use of the library and be induced to make a practice of using the room and to cultivate a liking and desire for books of literature, fiction, travel, industry, and the sciences. They are entitled to the opportunity, and the room and training should be made attractive so that attendance will be

Fig. 252. — Library, Junior High School, Trenton, New Jersey. *Mr. William A. Poland, Architect.*

voluntary rather than compulsory. What follows regarding the high school is equally applicable to the intermediate, modified in proportion to the relative sizes of the two schools.

It is, however, around the high school that the greatest activity in library work exists, and in discussing size, the question of the number of rooms given to the library department is important. In a high school of from 150 to 1000 pupils, a single reference room capable of seating from 25 to 60 pupils, with a small workroom about $10' \times 12'$ for the librarian, is probably ample, and all that such a school plant can afford. (See Figure 253.) But for the large high school of from 1200 to 2500, exclusive of the number of continuation students, there should be a reference room, workroom, combined museum and classroom, and a stackroom. (See Figure 254.) The reference or reading room should be large enough to seat at least 8 per cent of the day school enrollment, and this should be increased to 10 per cent if the plant is used also as a continuation school. The basis of measurement is to allow 20 to 25 square feet for each reader. This will provide floor space for aisles, tables, cases, etc. (See Figure 255.) If the library is to be used as a study room, replacing or supplementing one of the prevailing systems, the room will necessarily have to be larger, and the problem then becomes a subject for special investigation, with the administrative policy of the school a very determining factor.

The library classroom is really a small lecture room capable of seating from 30 to 40 students. It should also serve as the library museum, the museum cases being placed along the walls of the room. An area included within $25' \times 35'$ will be sufficient to seat the class and give considerable wall space for the museum cases. Besides having museum cases, it should be equipped with tablet armchairs, electrical receptacle for a low-power reflectroscope, a screen for lantern projections, a small stage, bulletin boards, and a black-



PLAN OF LIBRARY FOR A SMALL SCHOOL OF FROM 500 TO 1000 PUPILS

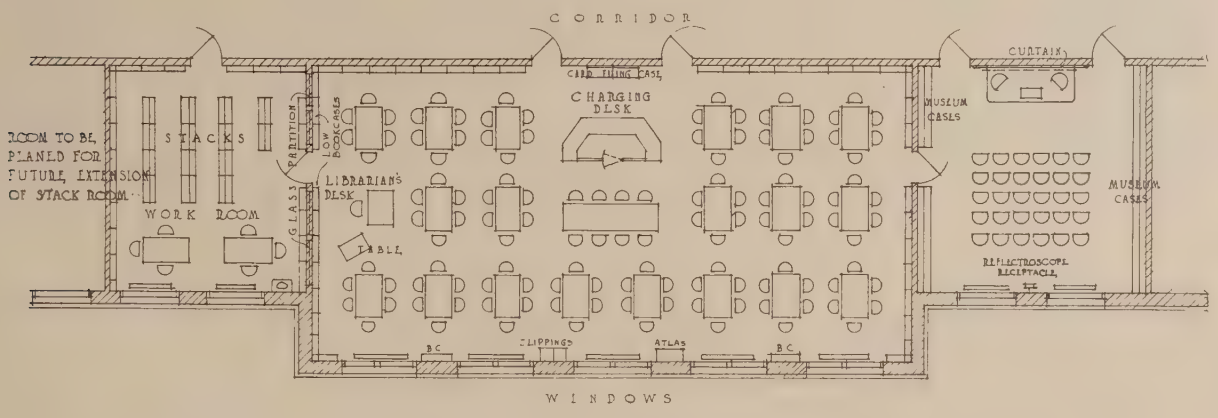
SCALE

FIG. 253.

board at the front of the room above the stage. In order that the room may be darkened, the window casing should be recessed as described under Physics (page 353). Two sets of window shades, opaque and translucent, are necessary.

The workroom and stackroom might very well be combined, allowing a section of about 12′×16′ of the room for the repair and cataloguing of books. The space for repairing should be provided with a lavatory, work tables, and ample shelf space for the storage of floor. In each tier there are usually six movable shelves and one fixed shelf, 3′ 0″ long, adjustable on 1″ centers, and 8″ or 10″ deep. (See Figure 256.) An allowance of from 30 to 35 pounds per cubic foot should be made for the book ranges. Book capacities per linear foot of shelving may be figured on the following basis: law books, five volumes; reference books, six volumes; scientific books, seven volumes; general literature, from eight to ten volumes.

In cases where lack of floor space necessitates the use



PLAN OF LIBRARY FOR A HIGH SCHOOL OF 1800 TO 2500 PUPILS

SCALE

FIG. 254.

books. A stackroom will be found desirable in the future high school to store special books and those that, having outlived their usefulness, should still be saved for reference work. A stackroom is the best means of providing expansion for the reference or reading room.

Interior Construction. *Stacks.*[1] — In the construction of the standard metal stack, the book ranges are usually double faced, and the aisles at least 2′ 8″ in width. The regular tiers are 7′ 0″ or 7′ 6″ high. A footboard should raise the lowest shelf four to six inches from the floor. In the case of double tiers, the following suggestion is offered regarding the construction of metal book stacks, as a saving in cost of installation, and for convenience to the librarian: if the aisles between stacks are made 3′ 4″ in width and the double tiers are equipped with a horizontal sliding step-ladder similar to those used in shoe stores, hung on a guide supported on the frame of the top tier, then easy access to each stack is attainable without having to repeatedly climb stairs and retrace steps. This is more applicable to a school library where the accessions will

[1] *Kidder's Hand Book*, Sixteenth Edition.

FIG. 255. — LIBRARY, SCHENLEY SCHOOL, PITTSBURGH, PENNSYLVANIA.

Mr. Edward Stotz, Architect.

never be extremely large than to a general library where unlimited expansion must be provided by means of the usual tiers of stacks and the dividing floors.

Doors. — While there should be more than one pair of double doors to a large reference room, it will be found advantageous for the discipline of the reference room, if the students enter and leave the room near the charging desk. All doors should be equipped with liquid door checks to prevent them from closing noisily. While locks are necessary, push-plates and pull-handles should replace the knob and latch so that the doors are opened with the least possible disturbance. It is a good investment to have all doors and door frames of hollow metal and wire glass construction, the former equipped to close automatically. The mechanical difficulty of rapidly opening and closing automatically controlled doors during rush periods between classes can be overcome by opening the library doors during the period of the intermission. This will permit a steady flow of students into the room without the interference of the constantly moving door.

Flooring. — Battleship linoleum or cork tiling is the most satisfactory for library floors, as they are serviceable and cause very little noise from use.

Ventilation. — The library rooms should be well ventilated by the plenum system, and except in sections of the country having severe winter weather, it would be better to have the room heated by this means, as the space under the windows is valuable for shelving. Where the winters are rigorous, the dual systems of radiators and tempered air are necessary.

Lighting and Illumination. — The library should have the equivalent of 20 per cent of the floor area in glass area, and if the room has a sunny exposure, it will prove to be cheerful and inviting. For artificial lighting, the semi-indirect system is the most practical and the least expensive. The illumination should be designed so that the minimum candle-foot intensity in any part of the room is not less than 3.0 and, if possible, as high as 6.0. All lighting should be from above, as the tables in a school library are movable in order that the room may be adaptable for many activities.

Mr. Edward Stotz, Architect.

FIG. 256. — LIBRARY SHOWING SINGLE BOOKSTACK, UNIVERSITY OF CALIFORNIA, BERKELEY, CALIFORNIA.

Finish. — It is most desirable that the ceiling, walls, and trim be finished in light tones in order to reflect the greatest amount of light. Tones just off the white are best for ceilings; buffs, tans, and grays for the walls; and white oak, treated natural, for the trim. These will always give the best effect for school libraries. Finishing the room in oak simplifies the matter of color harmony in the selection of the equipment. The walls above the bookcases are usually formed into pleasing panels by the use of stencils of good patterns in keeping with the room. Picture moldings should be provided for the hanging of pictures and bas-relief casts of sculpture. (See Figures 257 and 258.) Well-executed mural paintings, decorative designs, and good casts are most appropriate for the reference room, and should be acquired from time to time with a good deal of judgment in their selection. By its composition in proportion, symmetry, and finish, and by its appointments, the library will reflect the quiet refined thought of the school. There is no department so capable of diffusing an intellectual atmosphere, or that can represent so well the dignity of the school, as the library.

Equipment. — The equipment of the library should be chosen for service and durability. It should be so arranged as not to restrict the discipline or obstruct a complete view of the entire room. Alcoves formed by stacks will affect the administration, but if required for additional shelving, they should be placed at the ends of the room so that the openings are towards the librarian's desk or station. (See Figures 259 and 260.)

The following is a summary of the equipment needed in every high school library:

Tables.
Shelving.
Chairs.
Charging desk.
Librarian's desk.
Catalogue case.
Periodical rack.
Atlas and dictionary case.
Bulletin boards.

Mr. H. Osgood Holland, Architect.

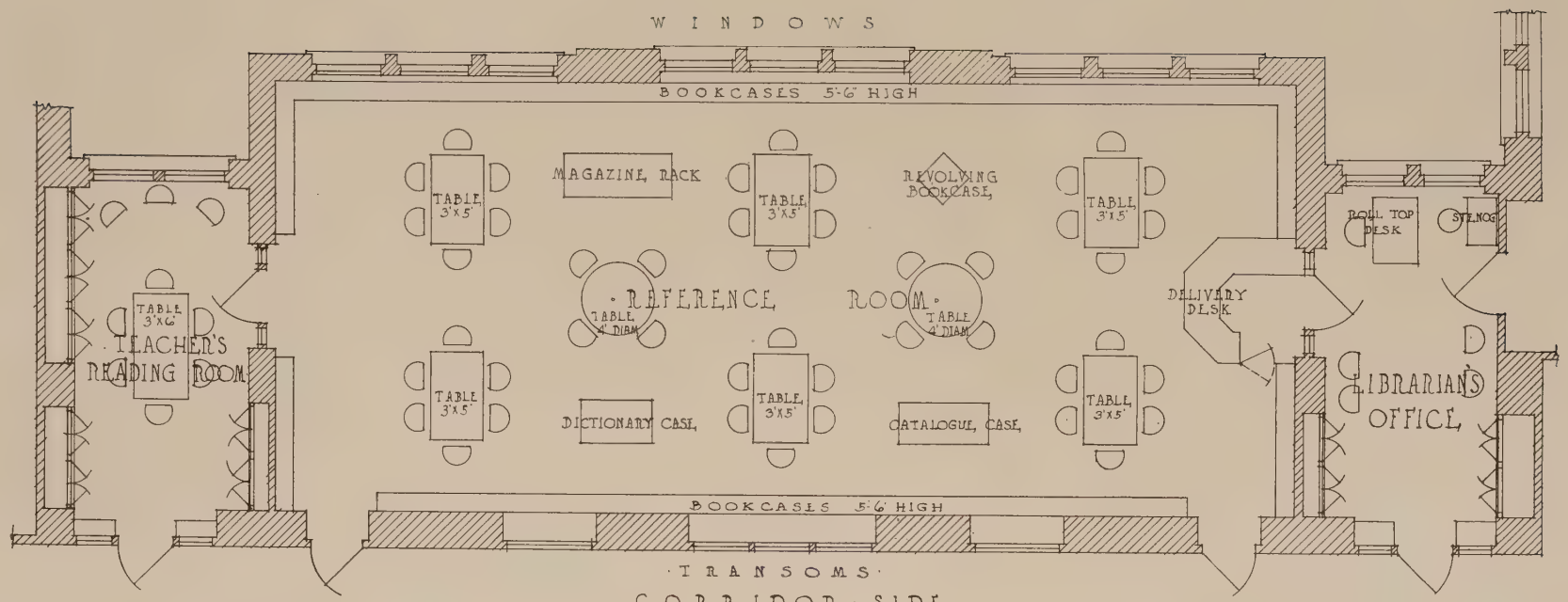
FIG. 257. — LIBRARY, HUTCHINSON CENTRAL HIGH SCHOOL, BUFFALO, NEW YORK.

Display cases.
Cabinets for pictures, pamphlets, etc.
Museum cases.
Map cases.
Phonograph and cabinet for records.

The tables should be arranged in rows with the ends parallel to the windows in order that the greater number may have the best lighting conditions. Also it is better to have a low limit to the number of pupils to each table for discipline and quietness. School library tables are 30″ high, and a table 3′×5′ will accommodate six pupils, two at each side and one at each end.[1] The unit of lateral measurement is 30″ for each seat. Pupils may be seated closer, but it is not good practice to crowd them and expect efficient work. Elbow room is as essential for reading and studying as for other forms of work. Crowding also restricts full use of the table for writing and drawing. Therefore, the unit of 30″ should be maintained in planning the table arrangement of the room. All furniture edges should be rounded, particularly those of tables. If the tables are made 3′×5′ it will be found that this size is convenient for easily rearranging the equipment of the room for other activities than that of regular library work. (Figures 261 and 262 show some of the possibilities.)

Shelving. — In the reference library, the book shelving should extend around the room on all available wall space, leaving the center of the room free for tables, cases, and desks. On account of its attractiveness, wood shelving is preferable to steel. The standard shelving (see Figures 263 and 264) is 6′ 10″ high, which permits the use of seven shelves 8″ deep, allowing 10″ in height between shelves. The bottom shelf is usually fixed, and all other shelves are adjustable on one inch

[1] The study-room library of the San Diego High School, San Diego, Cal., provides each reader with a small individual study table. Excellent concentration is thus attained.



PLAN OF LIBRARY · HUTCHINSON-CENTRAL HIGH SCHOOL · BUFFALO N.Y.

· H. OSGOOD HOLLAND ARCHITECT ·

0 5' 10' 15'

SCALE

FIG. 258.

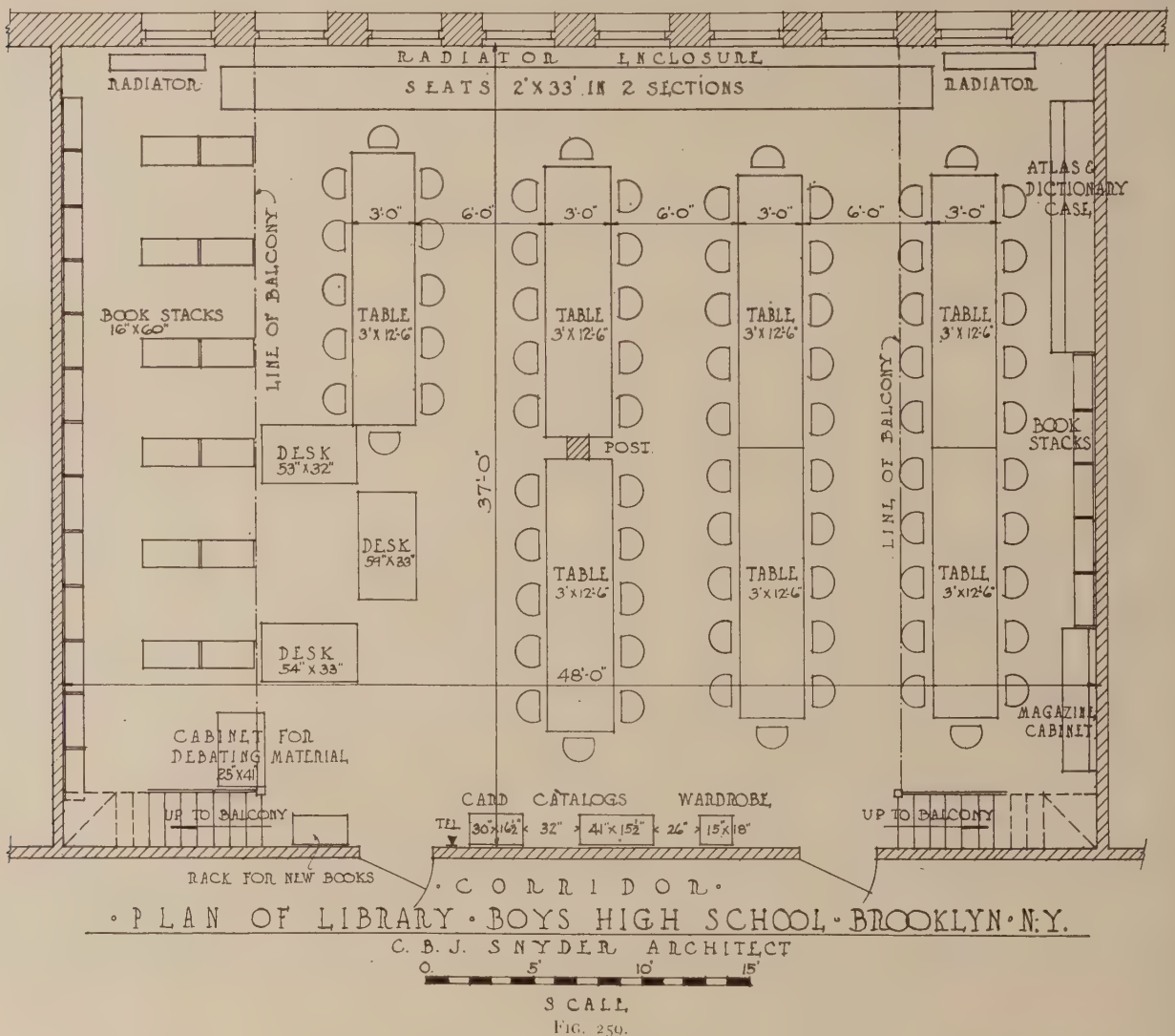


FIG. 250.

centers. The length of each section is 3′ 0″. About 10 per cent of the total shelving should be 10″ deep, and about 4 per cent 12″ deep, which will provide for over-sized books. All shelving should be open, with the exception of a few sections which should have glass doors with locks for the display of rare and finely illustrated editions.

Chairs. — This subject requires brief mention. Under the seat of chairs there should be a shelf for the temporary placing of text books carried to the room by the students, or to provide hat space. This will keep the table free for active work.

Desks. — Every school library should have a charging desk located near the exit. (See Figures 264, 265, 266.) This desk should be provided with sunken charging trays having a roll curtain, cash drawer, registration tray, book shelving, drawers, and cupboards for miscellaneous uses. In a very large school library, the stock charging desk may be found inadequate to handle the work of charging the loan and return of books between periods. It may be necessary to provide means so that the charging may be done by several attendants simultaneously. Here the librarian's ideas on the problem must be taken into consideration, and a special design of desk worked out through the collaboration of the librarian and the architect.

The librarian should be provided with a desk ample to provide space for her needs. Every year she orders hundreds of dollars worth of books, keeps numerous accounts, attends to correspondence, and interviews pupils and visitors. None of these can be done in connection with the charging of books. In fact, it is the librarian's desk that is the center of library discipline and not the charging desk. The latter should be situated as near as possible to the door which is used as the one exit from the room in order to expedite the work and

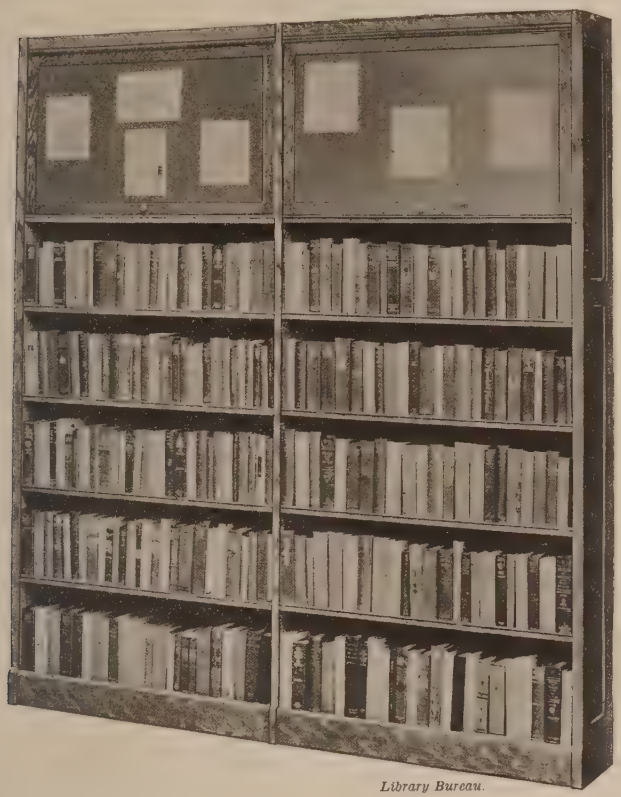
FIG. 260. — LIBRARY, GIRLS' HIGH SCHOOL, BROOKLYN, NEW YORK.

Mr. C. B. J. Snyder, Architect.

BIRMINGHAM REFERENCE LIBRARY

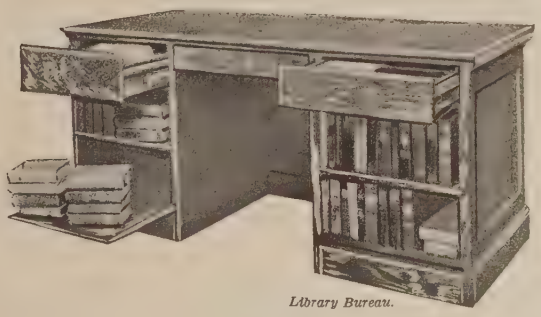
FIG. 261. — LIBRARY, GIRLS' HIGH SCHOOL, BROOKLYN, NEW YORK. *Mr. C. B. J. Snyder, Architect.*

FIG. 262.



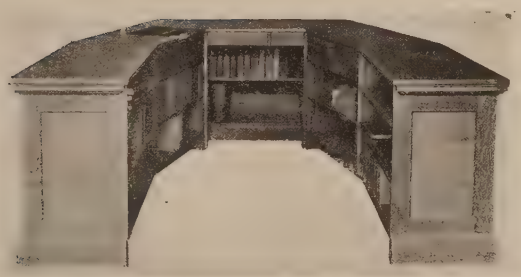
Library Bureau.

FIG. 263. — WALL SHELVING.



Library Bureau.

FIG. 266. — CHARGING DESK.

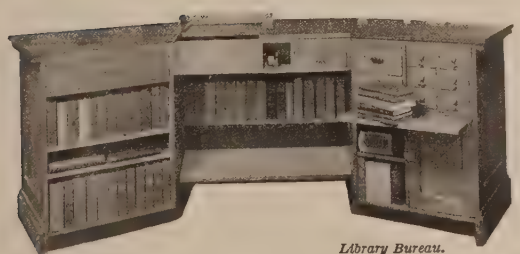


Library Bureau

FIG. 264. — CHARGING DESK.

Library Bureau

FIG. 267. — MAGAZINE RACK.



Library Bureau.

FIG. 265. — CHARGING DESK.

FIG. 268. — MUSEUM CASES, HUTCHINSON HIGH SCHOOL, BUFFALO, NEW YORK. *Library Bureau.*

to enable the attendant at the desk to see that no one takes a book from the library without first having it charged. The work of the charging desk constitutes the simplest and most mechanical part of library business, and it is usually deputed to student helpers or to the librarian's assistant. No capable school librarian should be doing the work of charging books. Her activity should center about her own desk, which, because it is the disciplinary center of the department, should be so located that from it can be commanded a view of the entire library room and, through the glass partition, of the workroom, also.

The remaining equipment, such as the catalogue cases, periodical racks, bulletin boards, etc., etc., are stock furniture and require no description as they are fixtures with which every school librarian is familiar. In planning the library, however, the furniture should be carefully shown on the preliminary drawings, and its location should be determined by the librarian as a check to show that the space allowed is adequate and also as an aid towards economic planning.

Fireproofing. — Because of the great value of the contents of the rooms, and on account of time necessary to acquire a good collection of books, the library department should be housed in fireproof rooms. Usually a library fire loss is irreparable, and for that reason every precaution should be taken to safeguard this section of the school plant. It has been previously mentioned that the doors should be of hollow metal and wire glass, closing authmatically. This is but one step in the right direction; others should be taken to have the floor construction of reënforced concrete, the walls of masonry construction, and the floors *above* of reënforced concrete; then a fire in another part of the building would very likely be controlled before seriously damaging the library

CHAPTER XV

CORRIDORS, STAIRWAYS, AND ENTRANCES

By John J. Donovan, B.S., *Architect*, A.I.A.

I. Corridors. (1) Width of Corridors in Elementary Schools. (2) Minimum Widths of Corridors, Elementary Schools. (3) Width of Corridors, High Schools. (4) Natural Lighting of Corridors. (5) Walls of Corridors. (6) Corridor Painting. (7) Corridor Floors. (8) Corridor Base. (9) Picture Moldings. (10) Recesses for Radiators. (11) Bulletin Boards. (12) Doors. II. Stairs and Stairways. (1) Location and Number of Stairways. (2) Stairway Inclosures. (3) Width of Stairs. (4) Stair Landings. (5) Balustrades and Handrails. (6) Risers and Treads. (7) Lighting of Stairways. (8) Storage Spaces under Stairs. (9) Stairways in the Schools of the City of New York. (10) Inclines or Ramps. (11) Construction of Stairways and Corridors. III. Entrances and Exits. IV. Fire Escapes.

Corridors. — The excellence of any school building plan is largely dependent upon the orderly arrangement of the corridors, stairways, entrances and exits. Whenever they are skillfully handled, the scheme immediately gives an impression of balance; and whenever they are unskillfully arranged the absence of this feeling is just as apparent. Correct plans of buildings are distinguished by the superiority of treatment of the channels of circulation. The psychology of this is the sense of safety conveyed, the directness of access to the different rooms and floors, and the adequacy of the passages to handle the flow of either occupants or material. With the requirements at hand, usually it is simple enough to assign spaces bounded by corridors, so that rooms and departments may be properly correlated.

The awful dread of fires in school buildings arises more from the anticipation of panics than from fear of the fire, and on this account corridors and exits should be planned to preclude as far as possible such dangers by having the corridor widths ample, the direction straight, and the lower termination at an exit. The time required to empty a building, and the number of rooms the corridor shall accommodate are matters to be considered in determining the amplitude of both corridors and exits. Whenever it requires more than three to three and a half minutes to vacate a school building completely, either the means of evacuation and the number of exits are inadequate, or the fire drill is poorly organized. Throughout the country, there is a desire for economy in the planning and construction of schools. That desire should be responded to in every sensible way; but the safety of children cannot be jeopardized by reducing the size of corridors and the number of stairways to an extent that would unwisely limit the possibilities for quick and orderly egress from the building.

Width of Corridors in Elementary Schools. — Considering the elementary school first: The Boston Schoolhouse Department requires corridors not less than eight feet in width for four rooms on a floor; not less than ten feet in width for over four rooms; and greater width in others according to their length and accessibility to stairs, etc. This requirement does not appear to be sufficiently definite, as it leaves the question open for debate until such time as the preliminary plans are presented for examination, thus leading to a waste of effort and time. Fixed standards of widths for corridors that will provide safety and comfort, and determined by the exact number of classrooms accommodated, should be arbitrarily established by laws that would forbid deviation therefrom. Accessibility to stairs is the governing factor in determining the width of the corridor, but assuming that no schoolhouse of more than one story in height would ever be built with less than two stairways, the following widths are given as a basis to work from:

Corridors with classrooms and departmental rooms on one side only, accommodating four rooms or less, should be 9′ 0″ in width; for each additional room 6″ should be added. Corridors with rooms on each side, accommodating four rooms or less, should be 9′ 0″ wide; additional two rooms, 1′ 0″ should be added to this width. From this may be formulated the following table:

Minimum widths of corridors in Elementary School Buildings of more than one story:

Rooms on one side only.

Table No. 1

Number of Rooms	
4 or less, corridor width,	9′ 0″.
5 or less, corridor width,	9′ 6″.
6 or less, corridor width,	10′ 0″.
7 or less, corridor width,	10′ 6″.
8 or less, corridor width,	11′ 0″.

Mr. Wm. B. Ittner, Architect.

FIG. 269. — MAIN CORRIDOR, CENTRAL HIGH SCHOOL, WASHINGTON, D. C.

Rooms on each side.

TABLE NO. 2

4 rooms, corridor width, 9′ 0″.
6 rooms, corridor width, 10′ 0″.
8 rooms, corridor width, 11′ 0″.
10 rooms, corridor width, 12′ 0″.
12 rooms, corridor width, 13′ 0″.
14 rooms, corridor width, 14′ 0″.
16 rooms, corridor width, 15′ 0″.
18 rooms, corridor width, 16′ 0″.

It is unlikely that secondary corridors would be planned to accommodate more than four rooms, that main corridors with rooms on one side only would have more than six to eight classrooms to accommodate. It would not be economical to go beyond that number in planning a school of this type. For this reason, the corridor with rooms on each side requires more consideration.

The minimum width of 10′ 0″ is better if stairways are at either end, as the width of stairs between handrails, or between divisions of stairs in elementary schools, should be 4′ 0″ or multiples of 4′ 0″. This subject is further discussed under the consideration of stairways. When stairways are at right angles to the long axis of the corridor, and a stairway is provided for each bank of four classrooms or the equivalent in pupil capacity, it is possible to limit the maximum width of corridor with rooms on one side to 12′ 0″. This dimension is given to encourage choosing wide corridors for school buildings of this type, as it forestalls congestion should boards of education later place additional rooms on the open side of such passageways. In St. Louis, the Bryan Hill and Wm. Glasgow Jr. schools, both designed by Wm. B. Ittner, Architect, and excellent examples of elementary school planning, have the main corridors 14′ 0″ in width. The former has twelve classrooms on the second floor and eight classrooms and kindergarten on the first floor; while the Glasgow school has fourteen classrooms on the second floor and eleven classrooms and kindergarten on the first floor. The ample width of these corridors gives an impression of safety to these two plans.

Width of Corridors in High Schools. — Corridors in high schools should be wider than those in elementary schools of approximately the same number of rooms and pupils, on account of the larger size of the pupils and the undesirability of having boys and girls of high school age crowd together in passing and moving along the corridors. Secondary corridors ought to be not less than 10′ 0″ in width, and the width of main corridors which are flanked by rooms on each side should be based on the following table which has been compiled from most reliable data:

TABLE NO. 3

6 rooms or less, corridor width, 10′ 0″.
8 rooms or less, corridor width, 11′ 0″.
10 rooms or less, corridor width, 12′ 0″.
12 rooms or less, corridor width, 13′ 0″.
14 rooms or less, corridor width, 14′ 0″.
16 rooms or less, corridor width, 15′ 0″.
18 rooms or less, corridor width, 16′ 0″.
20 rooms or less, corridor width, 17′ 0″.

Natural Lighting of Corridors. — When rooms are only on one side of a corridor, there is ample natural light. (See Figure 269.) But when corridors have rooms on each side, the corridor should be lighted by spacious light courts, or better yet, by recesses in the plan so placed that each section of the corridor will be given direct light. Unhygienic conditions are ever present in a poorly lighted corridor and in those having only borrowed or reflected light. The feeling of danger is always magnified. It is not sufficient to light long corridors from the ends when stairways are placed there, as the stairs obstruct the greater part of the light. This obstruction is, of course, increased when the stairs are crowded with pupils. Whenever these conditions prevail, light should be borrowed most generously by means of transoms and glass panel doors, glazed with a diffusing glass. The latter method of lighting a corridor is warranted only in exceptional cases, such as in corridors of short length. It should be a fundamental principle in planning school buildings that corridors shall be properly lighted by direct light and at the same time be capable of ventilation with fresh air supplied by opening the windows.

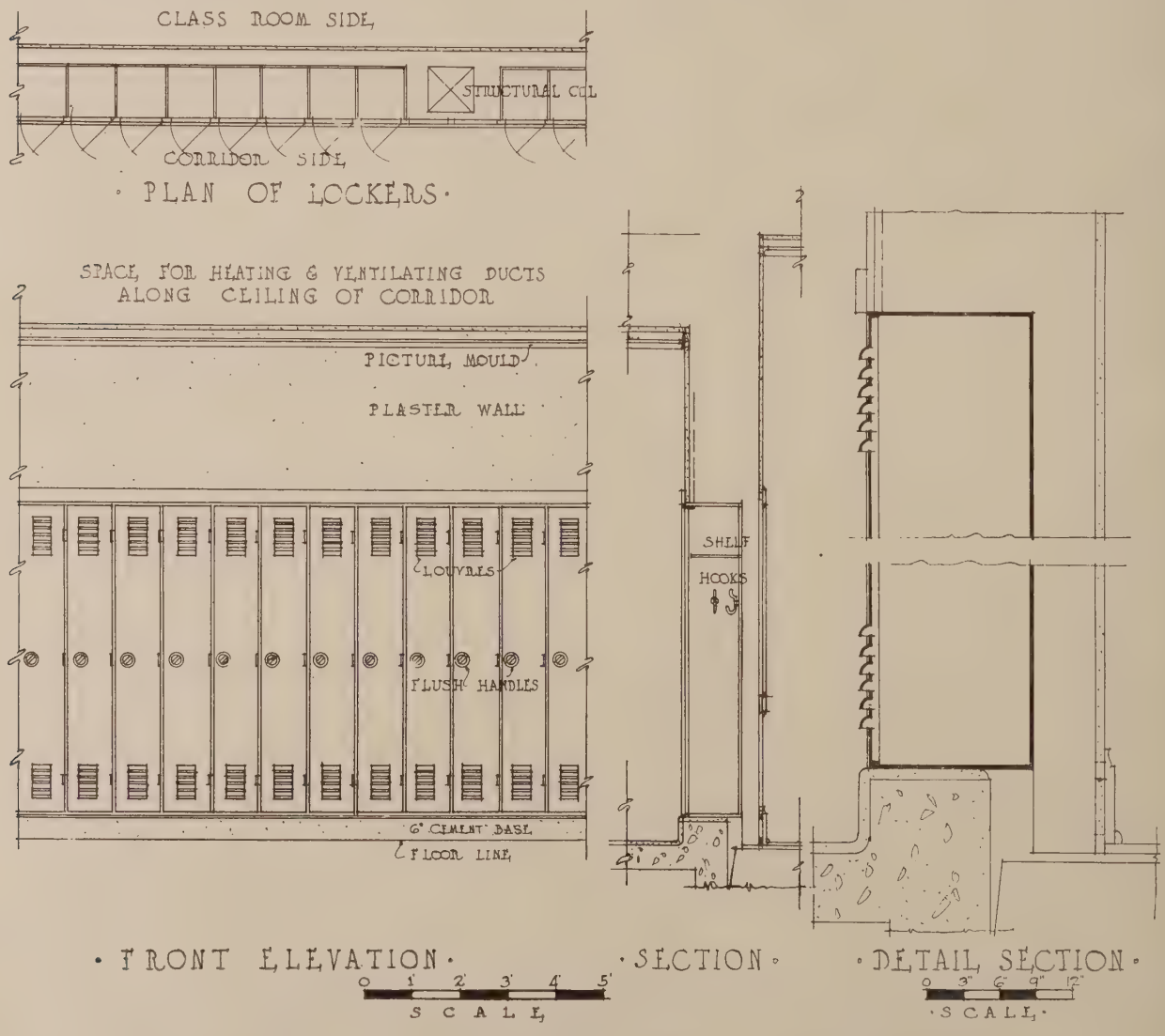
Corridor walls may be made to serve as the school galleries for the display of paintings and pieces of sculpture or the relics of archeology, and it is of course important that works of art should receive proper light to show to best advantage. Artificial light does not reveal to the best advantage the technical characteristics of either paintings or casts. The E and H shaped plans are by far the best forms to provide direct light to corridors for this purpose.

Walls of Corridors. — Corridor walls in school buildings to a point at least 5′ 0″ above the floor are subjected to hard usage, and it is not an easy problem even to-day to find an inexpensive material that will withstand wear and at the same time prove sanitary and hygienic. Whenever the structural walls are of masonry construction, glazed brick, bonded into the rough brickwork, serves very well. The joints, however, eventually become dark, and offer lodging places for dust and dirt. When glazed bricks are used, they should be laid so the face of the wall is flush with the finished plaster. Glazed or vitreous tile wainscoting gives a smooth and pleasing surface, but the ordinary glazed tile is easily subject to

breakage. The expense, however, of such surfacing is almost prohibitive in a school of large floor area or for general construction. Burlap, glued on to a plaster wall, is often used, and if it is specially prepared for such work and is properly applied, will last for a long time. But when it starts to peel off, the corridor presents an unsightly appearance. Cement plaster and hard wall plaster are most commonly used as the finish of corridor walls, and were it not for the susceptibility of plaster to damage, it would be the most satisfactory surface. Wood wainscoting, if of hard wood and with some attention to the design, makes not only a pleasing finish for school corridor walls, but will also withstand the ordinary rough usage. On the other hand, its use in a fireproof or semi-fireproof school, of course, nullifies the efforts to minimize the fire hazards.

In high schools, where the depth of wall is 12″ or more, the corridor walls are often planned to hold built-in lockers. This admirably serves as a durable wainscot and is much favored by many school administrators. If the lockers are of metal construction and are flush with the plaster above and with a cement base at the floor, the prevailing sanitary conditions are especially good. Such lockers should have recessed handles in order to avoid injury to clothing or person. (See Figure 270.)

Corridor Painting. — The walls and ceilings should be treated in light colors so as to reflect the greatest possible amount of light. A pleasing stencil of decorative ornament will enhance the appearance and enliven the walls of these long spaces. As previously mentioned, the corridor should be the art gallery of the school. Consequently, any special decoration of the walls should



TYPICAL STEEL LOCKERS IN CORRIDORS

Fig 27c.

be in good taste and in keeping with the character and the grade of the school. A tone of refinement will prevail throughout the school if discernment and judgment are exercised in selecting quiet, harmonious colors, and appropriate decoration for corridors and entrances.

Corridor Floors. — Were it not that cost is constantly the perplexing question, it would be simple enough to choose the materials for any and all structures. Under the heading, "Construction of Corridors," floors will be discussed again. At this point it ought to be noted that floors of corridors should be of a material or composition of materials which is washable, permanent, resilient, noiseless as possible when walked upon, and possessing pleasing and lasting color. It should also be capable of local repair without entailing high cost or the removal of a large part of the surface.

Marble and ceramic tile are rarely considered on account of cost and the danger of accident on the slippery surface. Moreover, the noise from walking on marble or tile will prove distracting to adjacent classrooms. Whenever marble is used, the exposed surface should be honed.

Cement is dusty unless treated with a successful floor hardener and then painted with at least three good coats of a good concrete floor paint. It will also be found that cement surfaces for corridor floors will require frequent repainting, and that generally they should be avoided.

Terrazzo, which is made of marble or granite chips, coarse sand, and cement, makes a fairly good and enduring corridor floor. Unless the floor area is divided off into panels about 10 feet in length and formed with marble strips or separately laid borders of terrazzo, cracks, due to expansion and contraction of the cement, are bound to occur. This is true of cement floors as well as of terrazzo. Terrazzo and cement are more nearly noiseless than either marble or tile and may be easily cleaned.

Magnesium compositions are resilient, make pleasing floors to walk upon and reflect very little noise. But the important factor in using composition flooring is to be able to select the right kind of the many makes and to have experienced and capable mechanics perform the work. Battleship linoleum is probably the most adaptable and gives the best results for the costs, as it meets nearly all the requirements of a corridor floor for school buildings. Cork tile is by far the best of all the materials were it not for the expense. At normal times it costs about seventy cents a square foot when laid in large quantities. It has all the good qualities of battleship linoleum and is more permanent. A good compromise is to lay cork tile flooring 6′ 0″ wide along the center of the corridor and flank this with wood or terrazzo flooring to the base. Then the noise of walking in the corridor during recitation or study periods will not disturb the pupils in the classrooms. When the corridor floor must be of wood it should be laid with maple flooring $2\frac{1}{4}'' \times \frac{13}{16}''$, tongued and grooved and thoroughly oiled, or treated frequently with linseed oil and petroleum naphtha. Wood floors should never be washed unless just prior to oiling, as the flooring shrinks and leaves cracks for dirt.

Corridor Base. — Unless the floor is of wood construction, all corridor and stairway bases should be of cement, terrazzo, or glazed tile, coved at the floor and rounded at the top, or better yet, flush with the wall line above. Whenever lockers are built into the walls, they should be set on top of the sanitary base. Where it is obligatory to install a wood base, there should be either a wood coved shoe at the floor, or a quarter round or similar molding nailed to the floor, so that cleaning at the angles formed by the floor and the base may be done effectively.

Picture Moldings. — All corridors should have picture moldings for the hanging of pictures or casts of sculpture.

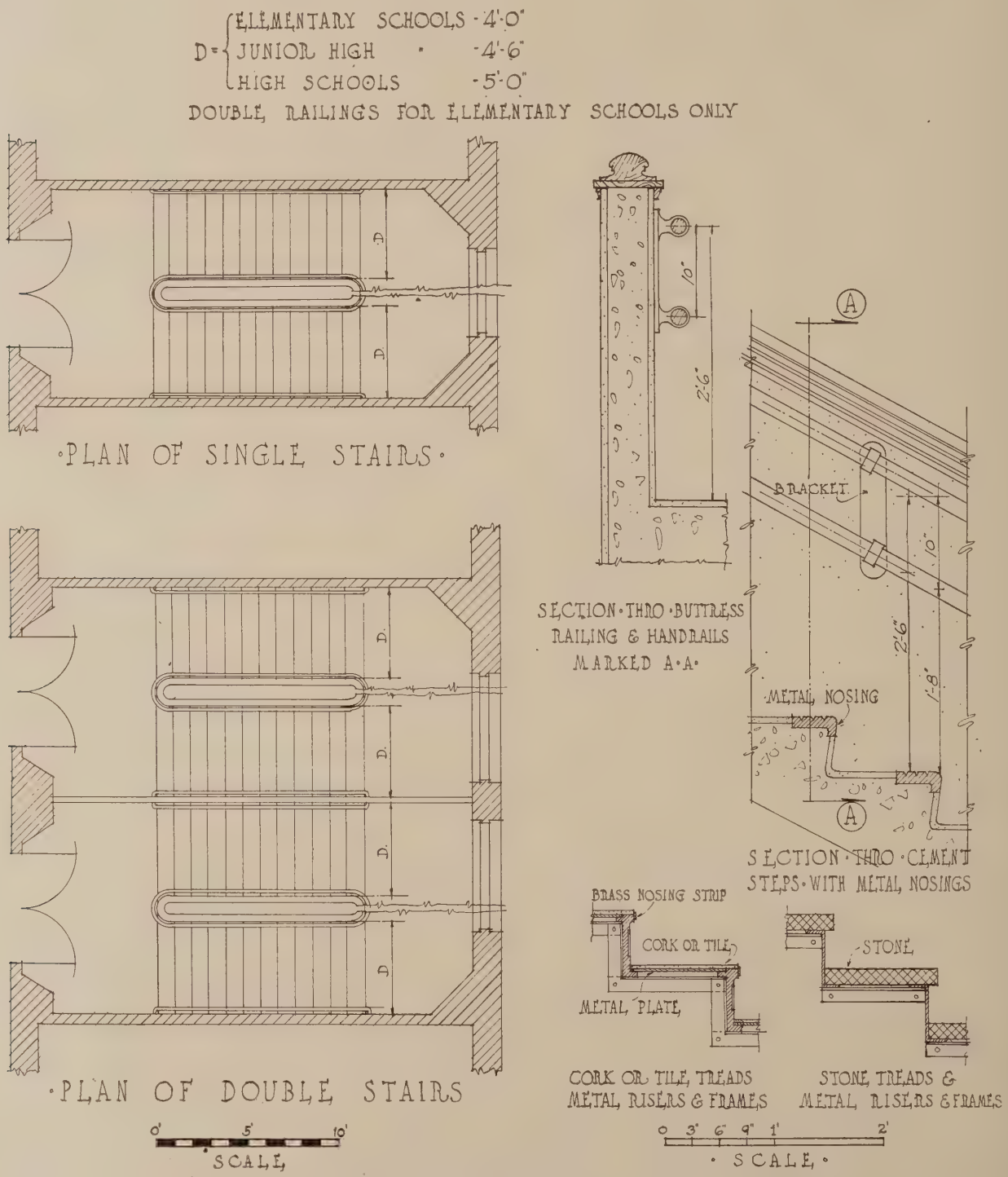
Recesses for Radiators, etc. — Radiators, hose reels, drinking-fountains, and supports for fire extinguishers should be recessed into the walls of the corridors. No obstruction, whatever, should be permitted to interfere with the full width of the passageway.

Bulletin Boards. — Corridor walls, when well lighted, near the administration offices, are splendid locations for large bulletin boards for the posting of notices by the principal and the officers of the various student organizations. These bulletin boards may be either long blackboards, equipped as in classrooms, or cork mats.

Doors. — All doors opening into the corridors should be hung with hinges that will permit the doors to swing back the full 180 degrees against the wall, and they should be provided with fasteners to hold them in that position. This necessitates hanging the doors flush with the corridor wall surface.

All fire doors opening into the storage rooms, boiler rooms, from corridors or to stairs leading to the boiler rooms should be of hollow metal construction or metal-covered on both sides, and the frames should be similarly made. There ought to be some design to these doors on the corridor side so as not to mar the general appearance of the corridor. When such doors have the upper panel in glass they should be glazed with corrugated wire glass, $\frac{1}{4}''$ thick. All such doors should open into the room or stairs from the corridor and should close automatically. Such construction will prevent the passage of smoke into the corridor, should a fire or explosion occur in the boiler room.

Stairs and Stairways. — A school building may be what is generally recognized as a fire-resisting structure and yet be a hazardous building for the occupants. This may be easily demonstrated. Imagine a school building with its structural members of steel encased in fireproofed materials, or of reënforced concrete, and its floors and exterior walls of concrete or masonry construction; the interior partitions and finish are made of incombustible materials. What advantage would there be in the fireproof part of the construction if the


D = ELEMENTARY SCHOOLS - 4'-0"
JUNIOR HIGH - 4'-6"
HIGH SCHOOLS - 5'-0"
DOUBLE RAILINGS FOR ELEMENTARY SCHOOLS ONLY
PLAN OF SINGLE STAIRS
PLAN OF DOUBLE STAIRS
SCALE
SECTION THRO BUTTRESS RAILING & HANDRAILS MARKED A-A
BRACKET
METAL NOSING
SECTION THRO CEMENT STEPS WITH METAL NOSINGS
BRASS NOSING STRIP
CORK OR TILE
METAL PLATE
STONE
CORK OR TILE TREADS METAL RISERS & FRAMES
STONE TREADS & METAL RISERS & FRAMES
SCALE

TYPICAL STAIR PLANS & DIFFERENT TYPES OF TREADS AND RISERS

FIG. 271.

stairways were inadequate, or improperly constructed? The more serious danger is always from the effects of panic rather than from fire. The only advantage would be in the failure of dead bodies to burn or in the lessening of some causes for a general fire. The story of every tragedy connected with fires in public buildings has been, that after the fire was discovered, a panic followed, and the stairs and exits became jammed or were cut off by smoke and fire. Panics are of course not always avoidable so long as the human mind is subject to fright, but the physical conditions conducive to them can be obviated if careful attention is given to direct and adequate means of safety. And it is therefore a public duty that all concerned give this particular factor just consideration when the merits of a school plan are being considered. It is highly probable that but a small percentage of schools to be built in the next fifty years will be entirely of fire-resisting construction. The tax burden would be too heavy. Beyond the fire limits of a city, it is not absolutely necessary to use such construction, if the building is not more than two stories above the basement, if precautionary methods are adopted in the design of the vital parts of the structure, and if there are ample stairways so that the building may be vacated quickly and with safety. The country is so far behind the educational requirements for housing facilities, that in order to catch up, it will be necessary to have to resort to extraordinary measures. These measures will be extraordinary because they must involve the construction of a great number of buildings which will meet all educational demands, and at the same time be safe, economical, and satisfactory in design as public buildings. One of the most important details in this new building movement, and one of the first to be mastered, is the matter of the location and number of stairways.

Location and Number of Stairways. — In examining the work in school construction of men of wide experience, it is noticeable that a stairway is provided for three and not more than four classrooms, or the equivalent of one stairway for every 120 to 140 pupils. Also the stairs are generally located so that should any one section of the building be cut off by fire or smoke, other sections and stairs are easily accessible for safety. The lower number of 120 pupils to a stairway for a three-story building, and the higher number, 140 pupils, for one of a two-story building, provides ample means of egress from the school at critical times. When a school is more than three stories in height, the number and location of stairs becomes a special problem and must be treated as such. Mr. C. B. J. Snyder, Architect of the Schools of the City of New York, a man who, on account of conditions prevailing in that city, is most eminently qualified to discuss this feature of school building, states that, "Our practice has been to estimate stair requirements on the basis of fifteen square feet per pupil for all rooms or spaces used for academic or other instruction. Frequent tests with a stop watch have shown that the capacity of a properly designed and built four-foot stairway (for elementary schools) can be readily counted upon at the rate of 100 pupils in 25 seconds, or 240 pupils per minute. In practice this is taken at 100 pupils in 50 seconds or 120 pupils per minute for each stair of four feet in width." [1]

From this it is evident that, if 120 pupils, marching two abreast, will pass a given point in a minute, that should be the number of pupils assigned to a stairway at the third floor in order to empty the building in three minutes, and in not more than three and one-half minutes after the alarm has been sounded. If the pupils on the second floor are forced by circumstances to use the same stairway as the children on the third floor, the progress of exit of the third floor pupils will be delayed accordingly, and under the most favorable drilling, any delay will quickly consume the safe time limit of egress and lead to impatience, which is the first sign of danger. Consequently, in planning for stairways, the architect should be informed of the formation and order of school fire drills, and he should then study to what extent the plan will permit changes in the line of march without causing confusion or congestion. Stairways should be located so that the distance between them and the groups of rooms accommodated is as short and direct as possible. It is not unusual to find they have been placed in some inconvenient, out-of-the-way corner, inadaptable to any other purpose, with no thought of their distance from rooms or of the number of pupils or rooms served by them. In studying the problem, the assumption should be frequently made that one or two stairways have been cut off by fire, smoke, or accident, after which the adequacy of the remaining stairways should be estimated. A test of this kind will quickly bring to light whether or not pupils in rooms or groups of rooms may become trapped. It is far better to take these measures into account when the preliminary drawings are presented for inspection than to wait until contracts are awarded or after the building is erected.

Stairway Enclosures. — With the possible exception of the main entrance stairways, extending from the ground floor to the first floor only, all stairways in buildings of more than two stories should be enclosed throughout the height of the building with wire glass and metal partitions, and the doors should always swing out towards the stairs and automatically close. When metal doors and metal partitions are found to be too expensive,

[1] Paper presented before the National Fire Protective Association's Twentieth Annual Meeting, Chicago, Ill., May 9th, 1916.

hard wood and wire glass should be substituted. Double swinging doors should be prohibited. The upper panels of all doors to stairways should be glazed with clear wire glass. Such doors should be equipped with push plates on the corridor side and pulls on handles on the stair side. Locks or fasteners to hold the doors either open or closed should not be allowed. If stairways are protected in this manner to shut off smoke and fire, and if they lead directly to exits, the pupils will be well protected.

Width of Stairs. — There is some question whether the width of stairs in elementary schools should be limited to 4′ 0″ or 5′ 0″ as a maximum width between handrails on walls and balustrades. The reason for establishing either of these widths is that it is less dangerous if children march outdoors from their rooms two abreast. When marching three or more abreast, the center child has no hand-rail support and is likely to stumble and throw the entire formation into a jam, with the result of blocking further movement if not creating a panic and disaster. The writer is of the opinion that elementary schools, from the first to the sixth grades inclusive, should have all stairs or divisions of stairs between hand-rails on walls and balustrades 4′ 0″ in width; in junior high or intermediate schools 4′ 6″ in width; and in high schools 5′ 0″ in width. These widths will then compel the files to be limited to two abreast, which is the right way to march pupils from schools. Whenever stairways are wider than the above dimensions, the widths should be of multiples of 4′ 0″, 4′ 6″, 5′ 0″, such as 8′ 0″, 9′ 0″, or 10′ 0″; they should be divided by a center railing or balustrade as is shown in Figure 271, and the railing should extend to the outside walls of the landings or follow the run of the stairs, depending on the design of the stairway. Stairways at the ends of corridors are generally limited to the width of the corridor, while stairways at right angles to the long axis of the corridor may be of any desirable width over-all. This statement, however, should not be considered a contradiction of the above estimate of the maximum width of divisions of stairs given in the tables, for regardless of the number of divisions, the maximum width of any division should not be greater than necessary for two abreast. It is a good plan to avoid having main stairways extend to the basement near the boiler rooms. Boiler rooms and rooms connected with or near the boiler room should be accessible by flights of stairs entirely separate from the stairs used by the pupils, and, as has been previously mentioned, they should be controlled by self-closing fire doors.

Stair Landings. — All stairways should have landings the width of the stairs and at one-half the story height. All these landings should be level. The corners or angles should be rounded or made octagonal so that a pupil cannot be pocketed during a rush. Winders, under no circumstances, should be permitted. A straight run of stairs with a landing is almost as bad as though it had no break in the flight. If a child should stumble above the landing or at the top, he would undoubtedly fall the entire length of the stairs. This type is uneconomical in consumption of floor area and in construction, besides being dangerous. Landings at floor levels should be spacious enough to give the enclosure doors full swing in order to allow space necessary for the free passage of the pupils on the stairs and those coming into and leaving them. When stairways are placed at the ends of corridors it is frequently convenient to place toilet rooms and closets at the level of the landing. This is hazardous, for often little or no attention is given to the swing of the doors, and if they open on to the landing, there is great danger of obstructing the stairs and causing confusion in the march out of the building. If the doors to such rooms occur on landings, they should be made to open into the room and not onto the landing; even should this be done, a frightened child may mistake such a door as a means of escape. Therefore, for safety, there should be no doors, openings, or recesses in the stairway walls except at the entrances and exits of the stairway at the floor levels. Seats on landings to serve as resting spots or nooks for sporadic studying are a menace, and regardless of such thoughtfulness for comfort, should never be permitted. Likewise pedestals for urns, flower pots, or any other obstacles to a clear passage should be eliminated.

Balustrades and Hand-rails. — Outside balustrades to stairs should be of closed construction. (Figure 272.) The open balustrade of iron bars or grilles give no protection to girls from those at lower levels. Furthermore, open balustrades provide lodgment for dust, and as janitor service is not always efficient in school buildings, it is better to adopt the closed balustrade. Balustrades on the outside, forming the stair well, should be at least 3′ 4″ above the nosing of the tread to prevent children falling from haste or crowding. The top of the balustrade should have a rounded hand-rail with square or rounded blocks for projections, spaced about 4′ 0″ apart to prevent boys sliding down the top of the balustrade and possibly falling the full height of the stair well. Unless this is done, a fireproof glazed partition should extend to the ceiling above the balustrade or from the stair stringer. This is, however, too expensive for general adoption. Two hand-rails for use by larger and smaller children should be securely attached to the walls of the balustrades and to the side walls of the stairway. The top hand-rail should be about 2′ 6″ above the tread, and on a line with the

FIG. 272. — DOUBLE STAIRWAY, SCHENLEY HIGH SCHOOL, PITTSBURGH, PENNSYLVANIA. *Mr. Edward Stotz, Architect.*

face of the riser; the lower hand-rail for the smaller children should be about 8″ to 10″ lower. If all principals would place the higher grades on the upper floors, the double run of hand-rails might not be necessary except for the lower flights of stairs; but we often find that school principals differ in their administrative methods. Stairways, if properly constructed, should be built so that if changes occur in the management or organization of the school, the safety of the pupils remains unaffected.

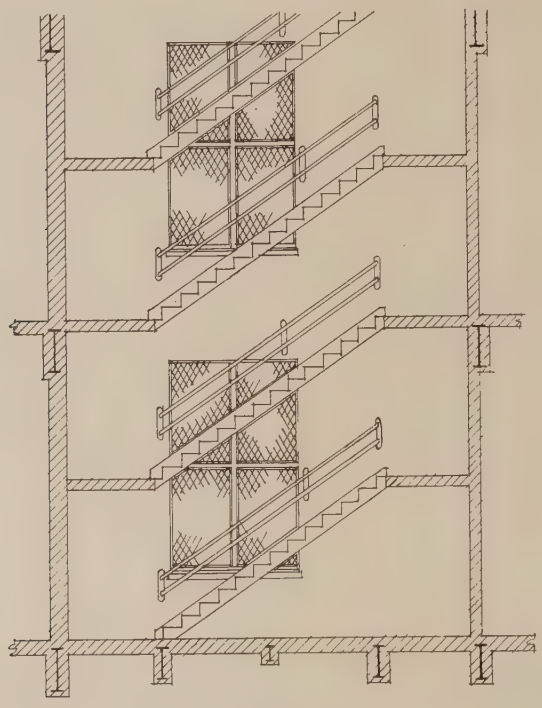
Risers and Treads. — In elementary schools, the height of the riser should not be more than 6″, and in junior and senior high schools the height should never exceed 7″; it is much easier for climbing if they too are limited to 6″. There are times in the construction of high schools when a compromise between 6″ and 7″ is necessary, but no riser heights should exceed 7″. The width of the tread is complementary to the height of the riser. Kidder's *Architects' and Builders' Pocket Book*, sixteenth edition, edited by Professor Thomas Nolan, of the University of Pennsylvania, states: "The width of the run should be determined by the height of the rise; the less the rise, the greater should be the run and vice-versa. Several rules have been given for proportioning the run to the rise:

"(1) The sum of the rise and the run should be equal to from 17″ to 17¼″.

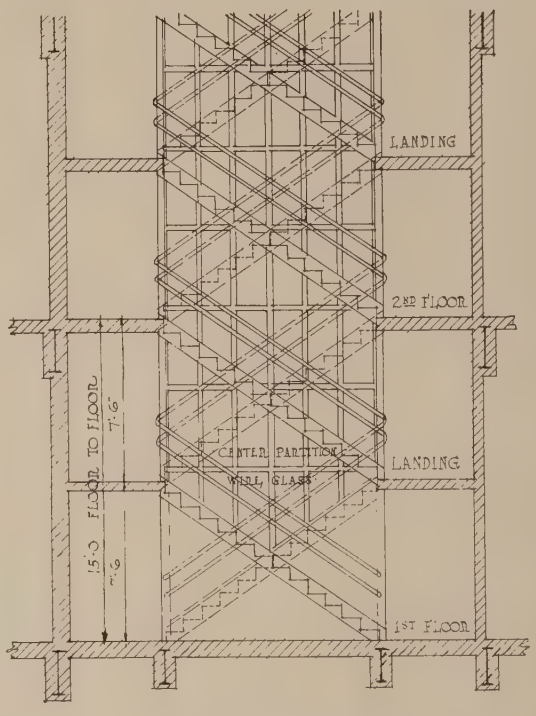
"(2) The sum of two risers and a tread should not be less than 24″ nor more than 25″.

"(3) The product of the rise and run should not be less than 70″ and not more than 75″. These rules apply to stairs with nosings."

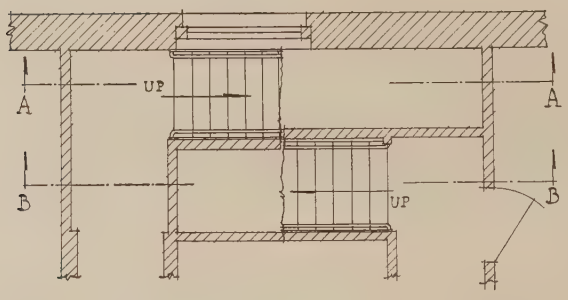
From this it would seem that for a 6″ rise the tread should be from 11″ to 11½″, and for a 7″ rise the tread should be from 10″ to 10½″. The measurement of a tread is either from nosing to nosing, or from riser to riser, and not from the riser to the nosing. For exterior stone or cement steps, the risers should be not more than from 5″ to 5½″, and the treads not less than 12″ in width.



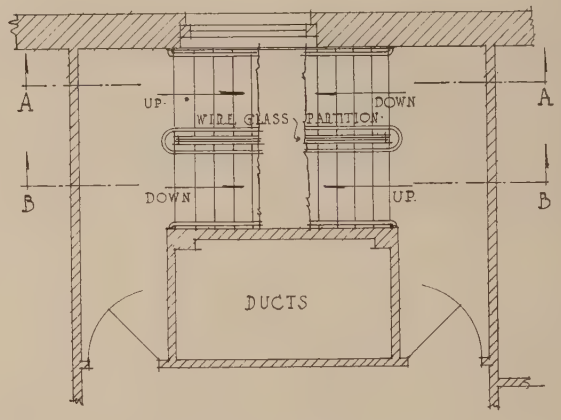
SECTION A·A



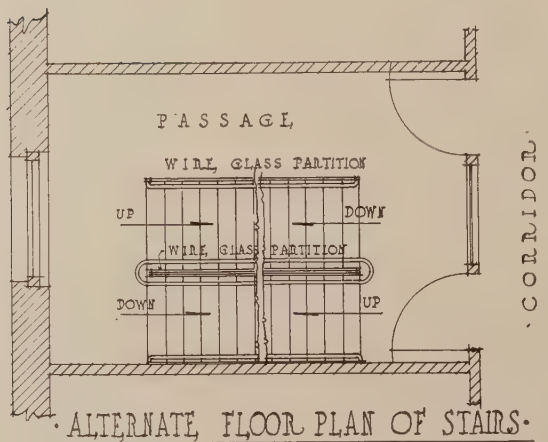
·SECTION B·B·



·PLAN AT FIRST FLOOR·



·TYPICAL FLOOR PLAN·



·ALTERNATE FLOOR PLAN OF STAIRS·

PLANS OF TYPICAL STAIRS

0' 5' 10' 15'

SCALE

TAKEN FROM DRAWINGS OF PUBLIC SCHOOL NO 29 BROOKLIN · NEW YORK. MR. C. B. J. SNYDER ARCHITECT.

FIG. 273.

FIG. 274. — MAIN ENTRANCE LOBBY, SCHENLEY HIGH SCHOOL, PITTSBURGH, PENNSYLVANIA. *Mr. Edward Stotz, Architect*

The material for stair treads is somewhat dependent upon the type of construction of the stairs. If the stairs are of iron or steel, the iron tread may be formed to receive asphalt, which makes a fine non-slipping tread and can easily be replaced or repaired, or of North River blue stone, magnesium composition, or of cork. Cork treads require a metal nosing or flange, as does asphalt, which is usually a part of the steel stair construction and set about $\frac{1}{8}''$ below the level of the tread. A danger of tripping exists here when the surface of the tread becomes worn. Slate and marble treads will not withstand the wear, and marble does not supply enough friction for safety. When the stair structure is of concrete, the treads are usually of cement finish or of terrazzo, with a " safety tread " consisting of steel and corrugations filled in with lead or carborundum and set flush with the finish of the tread. The " safety tread " is placed at the outside of the tread and kept about $4''$ away from the walls.

Lighting of Stairways. — Stairways should be well lighted naturally and electrically. (See Figure 272.) Any attempt to architecturally treat the exterior walls of stairways with long, narrow windows for special effect should be frowned upon. Plenty of daylight will often dispel fear. The old proverb that " danger lurks in dark places " is quite applicable to stairways. Interior stairways, not directly lighted, should never be permitted, regardless of the exigency. Whenever schools are near or adjacent to other buildings, the window frames and sash should be of metal and glazed with wire glass. This will prevent smoke from filling in stairways should a fire occur on the outside. The electric lights in corridors and stairways should be of ample wattage to provide a high illumination. Whenever service from two power companies is to be had, the outlets in corridors, stairways, and assembly halls should be wired from both sources of supply so that, should the service in one fail, there would be sufficient light to prevent serious accidents. This can be accomplished by having more than one lamp in each fixture and by dividing the lamps between the

Mr. A. F. Hussander, Architect.

FIG. 275. — MAIN ENTRANCE LOBBY, CARTER H. HARRISON TECHNICAL HIGH SCHOOL, CHICAGO, ILLINOIS.

FIG. 276. — MAIN ENTRANCE VESTIBULE, EDWARD LEE MCLEAN HIGH SCHOOL, GREENFIELD, OHIO.

Mr. Wm. B. Ittner, Architect.

different circuits. This is more necessary since the school has come to be used as much in the evening as during the day.

Storage Spaces under Stairs. — There is no better way to plan for a calamity in a school than to use the space under stairs for janitor's closets. Such spaces should be either sealed or left entirely open to view.

Stairways in the Schools of City of New York. — Much credit is due to Mr. C. B. J. Snyder, Architect for the Board of Education of the City of New York, for his contributions to schoolhouse planning and construction. His fireproof stairways, which so admirably provide for the safety of the occupants of schools that are special problems in the congested sections of that city, are decidedly ingenious. Figure 273 shows the construction and runs of these stairs. "The stairways are all of steel with cut stone or asphalt treads, and are enclosed from bottom to top with partitions on the corridor side made of wire glass set in steel frames, access being had to each floor landing by means of fireproof doors, all fitted with automatic checks and springs. This arrangement of stairways permits of a great saving in floor space and, while quite confusing to a stranger, is highly appreciated by the teacher who finds in them the certainty of easy and complete control of the pupils, and the pupils themselves quickly realize the fact that in these stairways lies perfect safety from the perils of fire, smoke, or overcrowding." [1]

Inclines or Ramps. — Inclines, unless placed in separate towers, are not practical for school buildings, and even then, are out of all reason in cost compared to the cost of well-built stairways. The proof of this lies in the floor space necessary to accommodate the rise and run of the incline. For instance, no ramp or incline should be installed when the slope is greater than 1 to 8. In other words, for every foot of height there should be 8 feet of run; for a story height of 14′ 3″, the horizontal distance traveled back and forth should equal 114 feet; for two stories 228 feet. Just what might happen at the turns, and particularly if the incline is steep, is entirely problematical.

Construction of Stairways and Corridors. — Notwithstanding an inclination to economize in the construction of school buildings, boards of education should deliberate on the wisdom of sane measures in safeguarding the lives of the occupants even if they involve some additional expense. One disaster is sufficient to cause a revulsion of feeling towards those in authority who consciously or unconsciously measure expense against safety of life. Very often, without a reliable estimate of the cost of the proposed buildings, requirements are established and bond issues set and placed before the electors, only to find, when it is too late, that the fixed amount is not sufficient to provide the necessary facilities. The usual recourse then is not only to reduce the number and often the size of rooms, but what is worse, to eliminate substantial construction in the parts of the building needing that sort of construction to assure safety. Architects are often as culpable as the laymen, and perhaps even more so, by underestimating the value of the work either through a desire to impress boards favorably or by a failure to grasp the many additional requirements of a school building beside rooms for instruction. The corridors and stairways should be the last section of the building to be cut in construction. The reader is requested to keep in mind that the author has a keen realization of the difference between substantial and extravagant planning and construction. What is set forth as substantial construction is intended to mean the actual, economical use of materials in a manner that will serve the purpose without embellishment. The additional percentage, in cost of building the corridor floors of reinforced concrete supported by reinforced concrete columns, and stairways of the same construction or of fireproof steel is small when compared with the total cost of the building. Corridor and stairway walls likewise should be of fireproof construction, whether of masonry, concrete, or metal lath and plaster. The last is not as desirable for the walls of stairways as brick or concrete, as the plaster applied to these materials is less subject to injury, and they are essentially fire resisting materials.

Entrances and Exits. — Entrances and exits to stairs and corridors should be like the wide end of a funnel. (See Figures 274, 275, and 276.) Particularly is this true of main entrances where corridors intersect, and at corridor entrances to assembly halls and rooms provided for large assemblages. Doors at entrances and exits should always open outwards and be equipped with panic bolts. Top and bottom bolts applied to the standing leaves of double doors are positively dangerous unless these bolts are controlled by panic bolt levers which cause the bolts to slide and the doors to fly open when the pressure of the body is applied to the horizontal levers, which should be about 3′ 0″ above the floor. Double acting and revolving doors at entrances to schools should be prohibited. Where inclosed vestibules are necessary to exclude the cold drafts of winter and a double set of doors is necessary, the vestibule should be wide enough to allow plenty of room for the inner doors to swing clear and then sufficient space left to give room to the vestibule. The inner set of doors should have no locks, and their equipment should consist of a push plate on the inside, and a pull handle on the

[1] Mr. Snyder in *Modern School Houses.*

outside, with a door check to automatically close the doors. All exterior doors should have some fastening device to hold them open when this is desired.

Fire Escapes. — A school building that requires fire escapes is an example of decidedly bad planning. The danger of falling from them is always so great they can never take the place of stairways, for children are not trained to use them. Fire marshals, experienced chiefs of fire departments, and those whose duty it is to fight fire, have generally agreed that they should not be used, except on old school buildings and then only when it is not practical to install stairways. When they are used, they should be 4′ 0″ wide and enclosed with wire glass and metal frames and equipped like a fireproof stairway. They then become outside stair towers.

CHAPTER XVI

THE ASSEMBLY HALL

By John J. Donovan, B.S., *Architect*, A.I.A.

I. Assembly Hall. II. Assembly Hall for Elementary School. III. Assembly Hall for Junior and Regular High Schools. (1) Seating Capacity. (2) Height. (3) Floor. (4) Divisions. (5) Location. IV. Stage. (1) Size of Stage. (2) Moving Picture Screen. (3) Control of Lights. V. Acoustics. (1) Source of Sound. (2) Control of Sound Waves. (3) Absorption of Sound Waves. (4) Coefficients of Absorption. (5) Reflecting Surfaces. (6) Wall Surfaces. VI. Organs. VII. Quietness. VIII. Moving Pictures. (1) Equipment and Current. (2) Construction. IX. Lighting and Illumination. X. Aisles. XI. Exits. XII. Painting and Decoration.

Assembly Hall. — No modern school can be properly equipped without an assembly hall. This part of the school organization has proved its worth. Its activities, fully as much as the activities of the classrooms, have stimulated young students to lives of useful endeavor. No other division of the intellectual equipment can exert a stronger moral influence on the student body. It is a kind of clearing house of ideas; a place of action, where the theories of learning are turned into realities. Nor is its use confined to the school alone. Without it many a community would be without a decent, safe, and comfortable hall to gather in. The old idea, that the assembly hall, like the old-fashioned family parlor, was a room to be used only on very special occasions, has given way to the realization that it should be used most intensively, not only during the day, but in the evenings and on Sundays as well. As the unfolding spirit of Democracy comes more and more to find expression in community singing, the organ will before long be considered as much a necessity in the school assembly hall as the moving picture booth is at the present time. When this point is reached, the assembly hall will offer the full value of its construction in terms of service to the day school, the continuation and evening schools, and to the community in community activities.

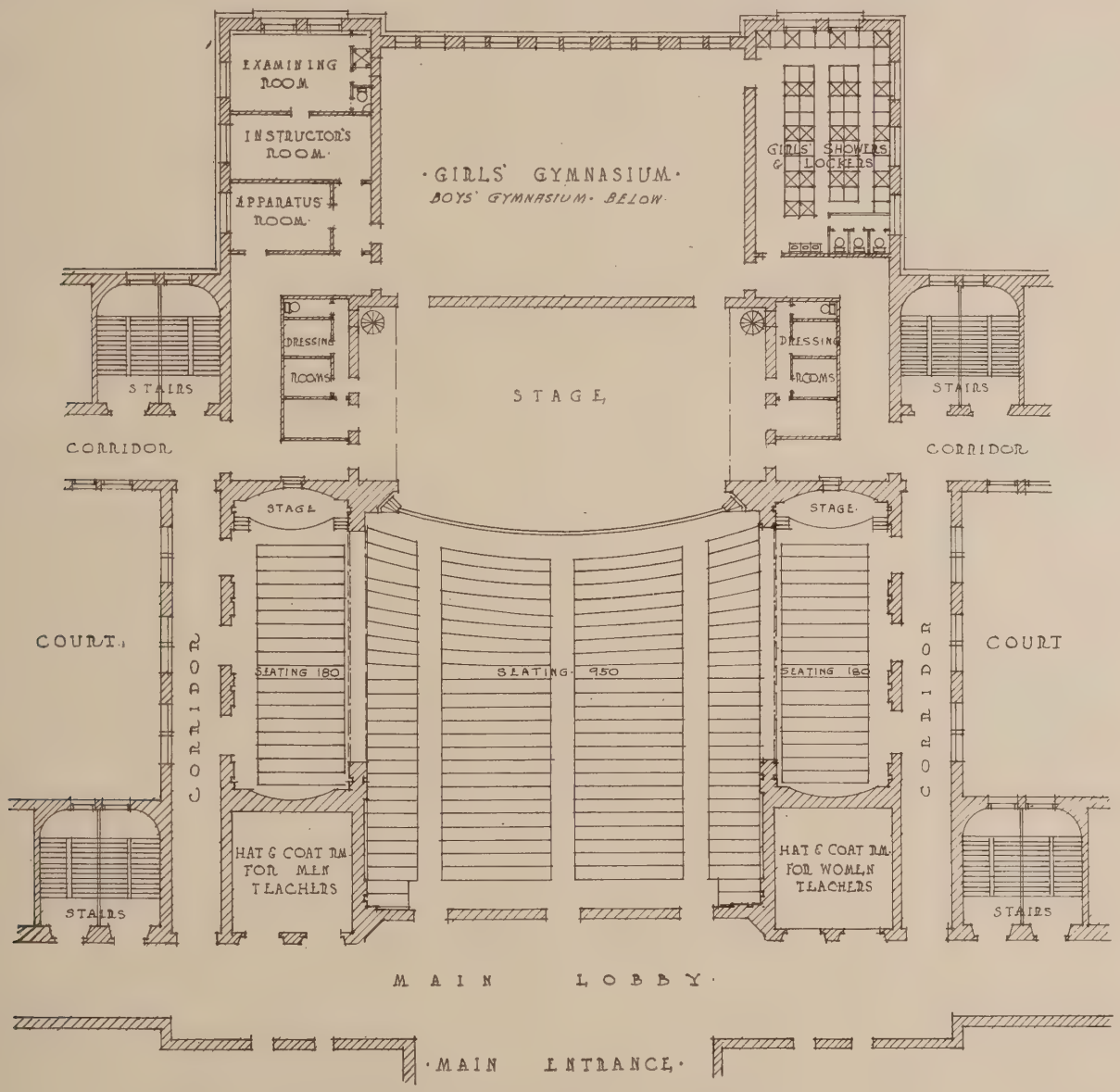
In the consideration of the appointments of an assembly hall, the question of the kind of stage to be built is of first importance. With the expansion of the modern school, the simple lecture platform can no longer be considered sufficient. It cannot possibly be made to answer the increasing uses to which the assembly hall is being put. The modern high school assembly hall stage must have all the essentials of a theater stage to provide the student with the appropriate environments for dramatic expression. The public is awake to the advantages of the assembly hall and appreciative of the pleasure derived from its use when it is constructed with good acoustical quality. The means and the knowledge are at hand, so that all such rooms may be built and finished to possess not only architectural merit but acoustical merit as well.

Whether or not every school should have an assembly hall is a question that is usually decided affirmatively by educators, but often to the contrary by those responsible for the tax rate. However, every school should have some arrangement for convocations, and if it is not possible at first to build an assembly hall, the dividing partitions of a number of classrooms should be constructed with folding doors so that two or three rooms may be formed into one long room. This plan is not very satisfactory, and on account of its limitations, is merely better than nothing at all. Whenever an assembly hall must be omitted, arrangement should be made in the general plan so that it can be added without becoming a misfit or seriously affecting the symmetry of the building.

Assembly Hall for Elementary Schools. — Elementary schools of five or more classrooms should have an assembly hall in order that the principal may call the school together for talks, or for choral instruction by the music teacher. The small school assembly hall should be simple in character and should be equipped with a small stage, moving picture booth, level floor, and movable chairs. The room can then be used for folk dancing and games by the pupils, and for social meetings by the community. The assembly hall for the large elementary school should be much the same, except that it should have a greater seating capacity. It is a question whether or not the hall should be capable

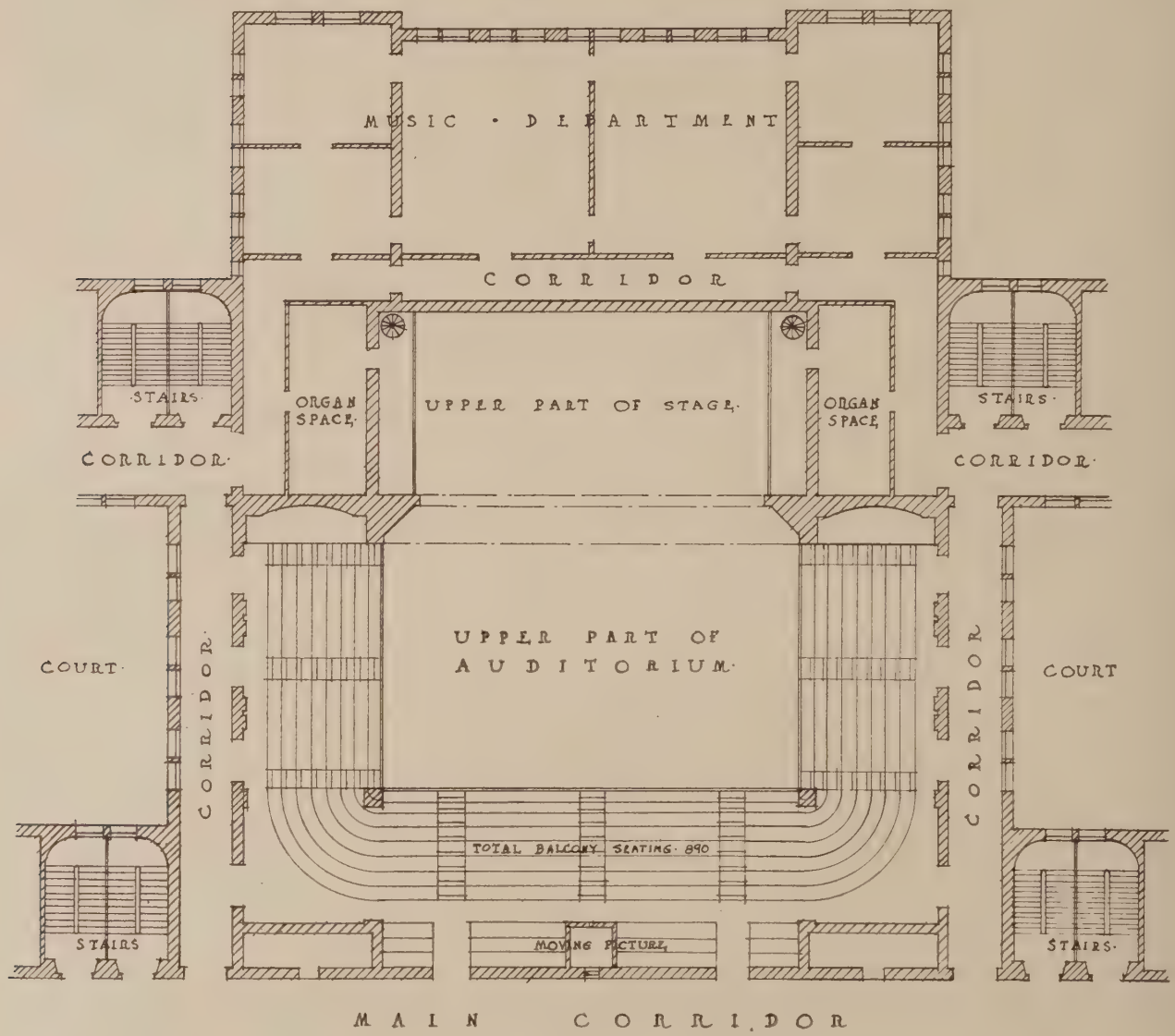
of seating the entire school enrollment. For elementary schools a seating capacity of four-sevenths of the enrollment is probably the correct estimate, as the pupils of the lower grades are usually excused from the general convocations.

Assembly Hall for Junior and Senior High Schools. — It is, however, in the assembly hall for the junior and senior high schools that good planning is most essential. It is absolutely necessary that auditoriums for high schools should be large enough to seat slightly more than the entire school enrollment, including the teaching staff, so as to provide for the future growth of the school. Any high school is at a great disadvantage if the entire school cannot be called together at the same time to hear an influential speaker or to discuss, as a student body, matters concerning the welfare of the school.



LARGE HIGH SCHOOL ASSEMBLY HALL SEATING 2200 STUDENTS

FIG. 277.



· SECOND FLOOR OR BALCONY PLAN ·

0 10' 20' 30'

SCALE

LARGE HIGH SCHOOL ASSEMBLY HALL SEATING 2200 STUDENTS

FIG. 278.

Seating Capacity. — To determine the seating capacity, an allowance of 6½ square feet per seat is generally adopted for seats in straight rows, and about 7½ square feet for those in curved rows. These dimensions provide for aisles, are confined to fixed seats, and do not include the space for the stage. Movable chairs will require a larger unit of measurement. Also a greater allowance should be made for tablet chairs. Assembly hall or theater chairs are made 19″, 20″, 21″, and 22″ wide. From this it is evident that, in order to seat a school of 1200, the main floor would have to be about 60′ wide × 75′ long; this area would accommodate approximately 700, leaving it for the balcony to seat the remaining 500. In order to seat a school of 2000, the main floor should be about 100′ wide × 75′ long, a space which would comfortably seat 1200. The balcony must extend well out over the main floor and return along the sides to the proscenium wall in order to accommodate the remaining 800. More than one balcony is not desirable, for it is always difficult to preserve order and hold the attention of pupils seated in the upper balcony or the gallery, as it is usually termed to distinguish it from the balcony proper.

Height. — The height of the assembly hall should be governed somewhat by the architectural treatment of the room, but more so by the correct cubic space necessary to provide for adequate ventilation. Thirty cubic feet of air per minute per person and six changes per hour are the standards generally required and adopted. A hall 100′ × 75′, seating 2000, would require a height of about 40′ above the stage level in order to meet the requirements of 150 cubic feet of space per seat, which is a moderate allowance. Some ordinances require 200 cubic feet per seat. Very often the noise of ventilating systems in assembly halls is due to the attempt to provide a volume of air computed upon the seating capacity without consideration of the cubical contents of the room. There are other causes such as poor engineering and faulty mechanical installations, but it is evident that the ventilating system will be handicapped if the cubic capacity of the room is too low. There is a tendency to cut down on the heights of assembly halls in order to reduce the cubage of the building, but it should be observed that this practice affects the acoustics of the room as well as the ventilation.

Floor. — Whenever the seating capacity of the main floor is greater than 500, the floor should be sloped or made saucer-shaped, and the seats should be set on steps. Otherwise, it is necessary to elevate the stage to an abnormal height, and even then a full view of the stage floor will be obstructed by the footlight apron. It is very important that every occupant of the auditorium have a clear view of the stage. With a sloping or saucer-shaped floor, the level of the eye should be established at a height of 4′ 0″ above the level of the steps for the seats, with each step 4″ above the one in front. This will provide unobstructed views and determine the slope of the curved section of the saucer. The height of the stage is established 3′ 9″ to 4′ 0″ above the low point of the assembly hall floor at a point located about 5′ 0″ back of the apron. From this height lines of vision are drawn to every row of seats.

Divisions. — The numerous uses to which the assembly hall is put have brought about the very practical division of the main floor into three sections as shown in Figs. 277 and 278. This division requires the use of rolling partitions back of the balcony supports and a small stage or rostrum at the front end of each of the side sections. By having especially deep recesses in the vertical frames of the rolling partitions, the three sections may be used at the same time with very little disturbance to any section.

Location. — For safety the main entrance of the assembly hall should be on a level with the first floor. It is a serious mistake to have it higher than this, for then the lives of the occupants will be jeopardized if for any reason it should be necessary for the entire audience to descend stairs within the building in order to reach the exits quickly. Usually the room is placed on axis with the main entrance for convenience to the pupils and the public. If the hall is used to any extent by the latter, collapsible iron gates should be installed across the corridors to prevent outsiders from wandering through other parts of the school building. Not infrequently the assembly hall occupies an end of the general plan, or projects in front of the school. Sometimes it may be a detached building connected to the main building by a cloister or an inclosed arcade. These schemes give more direct access to the room for the public, and there is then very little opportunity for promiscuous roaming through the school. The Technical High School, Oakland, California, the Oak Park School, Sacramento, California, and the Elko County High School, Elko, Nevada, are examples of three different methods of locating the assembly hall as above described.

The Stage. — For the lower grade schools, the rostrum at the end of the hall or the stage with small dressing rooms at the side and a moving picture screen may suffice for the activities within the hall. But for the junior and senior high schools, an effort should be made to provide form and equipment in order to widen the possibilities for development in expression, interpretation, and dramatics.

The semi-inclosed stage, with the space so limited as to be suitable for graduation exercises or speaking and

singing programs, will not meet the requirements of the modern high school. Consequently, there should be no obstructions to a free use of scenery suspended from a gridiron above.

Size. — For a school of 2000 the stage should be about 40′ × 100′ within the stage walls. The stage can then be used as a gymnasium, and if the proscenium opening is of ample width (about 65 feet), athletic contests such as basket ball, handball, volley ball, and even tennis may be played, with the audience comfortably seated in the auditorium. If a gridiron is installed, its height above the stage should be a few feet more than twice the height of the proscenium opening, and a space of about 6′ 6″ above the grids should be allowed for adjusting scenery tackle and blocks. The pin-rails and pin-rail balconies should be installed at the time of constructing the building. It is wise, however, to limit the scenery to two changes (interior and exterior sets) until the school performances bring returns for additional scenery equipment.

Moving Picture Screen. — The moving picture screen and machine are discussed under the chapter on *Physics*, but it should be noted that the screen should be rigidly fastened at the lower edge to the stage floor at an angle nearly perpendicular to the lantern's rays.

Control of Lights. — Footlights, border lights, and all illumination in the hall should be controlled at the main switchboard on the stage and in the moving picture booth. This operation requires on the switchboard an automatic electrically controlled switch, which in turn can be operated by a simple switch in the moving picture booth.

To some it may seem that equipping an assembly hall stage in this manner borders on extravagance, but a number of years of close relation with the large high school and acquaintance with the many educational activities related to the assembly hall prompts the writer to advocate the furnishing of facilities which will aid the development of the large number of students who will never have the opportunity to attend a university. Moreover, from the point of view of expense, the cost will be outbalanced by the uses to which the large well-equipped stage can be put. The smaller rostrum, with its many restrictions, can never be as satisfactory.

Acoustics. — This subject, on account of its technical character, will not admit of more than a simple, practical explanation of how to treat the interior surfaces of the assembly hall in order to obtain the proper acoustical quality for the room.[1] Much attention has been attracted to this matter during the last two decades on account of the noticeable lack of acoustical qualities of many school assembly halls and large public auditoriums in which audiences have heard indistinctly and sometimes not at all. This condition has been caused largely by the use of certain materials that have been favored by building ordinances because they are good fire retardants, and by builders because they require less effort in preparation and erection. Among these are metal lath, gypsum, plaster, plaster on brick, terra cotta tile, brick, and glass. Now while these materials have excellent qualities for the retardation of fire and for expedition in building, at the same time they have very low coefficients of the absorption of sound waves, and hence afford poor acoustical conditions for the halls in which they are used.

Source of Sound. — Sound is a form of energy that sets in motion the ether waves of space, by means of which it is carried to its final destination. These sound waves move in all directions, assuming spherical form after leaving the source, a single note or uttered syllable setting up an infinite number. Very few of them travel directly to the listener; most of them impinge against the walls, floors, seats, and the ceiling, from which, unless the building material is absorbent, they are reflected to travel again about the room. It is these reflected or secondary waves that accentuate the strength of the direct wave and add loudness to the sound. If both waves fail to reach the listener simultaneously, or within one-fifteenth of a second, of each other, he becomes conscious of a duplication of the same sound, usually called an echo. It is possible for one sound to produce several echoes in a room of ample size when the walls, ceiling, seats, and floors are constructed of hard and dense material against which the direct waves are readily reflected into secondary ones.

Control of Sound Waves. — It is evident that, if good acoustical quality is to be had in an assembly hall, it will be necessary to control reflection and prevent the dissipation of secondary waves. It is a well-known principle in physics, that, although energy is indestructible, it is, nevertheless, convertible, that is, when it is lost or absorbed, it has simply passed into some other form, such as heat or motion. Since ordinary sound is low in energy, its conversion into heat would be unappreciable. To control the secondary waves, it is necessary merely to replace sections of the reflecting surfaces with materials which will absorb these waves in such measure, that either their return to the audience is prevented or their strength is so diminished that they cannot interfere with the intensity and audibility of the direct waves. Ma-

[1] For a more comprehensive study of this subject the reader should consult the works of Professor Wallace C. Sabine, Harvard University, and those of Professor F. R. Watson of the University of Illinois. "Architectural Acoustics" in the *American Architect*, 1900, by the former, and Bulletins No. 73 and No. 87, University of Illinois, by the latter.

terials have much the same relation to sound waves as they have to light waves; that is, they absorb, transmit, or reflect the waves; or they may do all three. For instance, when a thin oiled skin like a drum head is placed over an opening exposed to the sun's rays, some light will pass through, some will be reflected, and some will be absorbed by it. The last will be made evident by placing the hand upon the skin and noting its warmth. On the other hand, a plain sheet of glass will almost totally transmit light, while the mirror nearly totally reflects light. Likewise, materials of soft texture, such as fabrics, transmit, absorb, and dissipate the sound waves; materials such as plaster, brick, steel, wood, glass, and cement absorb but little and greatly reflect sound.

Absorption of Sound Waves. — Such materials as "acoustical" hair felt, covered with burlap or rep, will suffice to absorb the secondary waves. Often rep is used alone. In this case it is placed over a cotton twill membrane fastened to furring strips so as to allow for an air space between the membrane and the structural wall. If the side and rear walls are divided into large panels, and the panels covered in this manner so that the greater number of secondary waves are prevented from returning with force to the listener, the room will most likely have a good acoustical quality, providing other conditions are fulfilled. Some of these conditions will be set forth later.

Coefficients of Absorption. — Professor Wallace C. Sabine, Professor of Physics, Harvard University, after a large number of experiments, determined the absorbing powers of many different materials. He called the open window a perfect absorber, and gave it a coefficient of *one;* in comparison with the open window the following materials would have the following proportional coefficients:[1]

One square meter of open window space	1.000
One square meter of audience	0.96
One square meter of hair felt 1″ thick	0.75
One square meter of heavy rugs and curtains	0.25
One square meter of linoleum loose on floor	0.12
One square meter of hard pine sheathing	0.161
One square meter of plaster on wood lath	0.034
One square meter of plaster on wire lath	0.033
One square meter of plaster on tile	0.025
One square meter of glass, single thickness	0.025
One square meter of brick set in Portland cement	0.025

From the above table it is noticeable that hair felt and textile materials are considerably higher in absorption power than the harder and more compact building materials. Recently a Gustivino tile has been developed which is said to have a high coefficient of absorption, for by the roughness of its surface the generation of friction dissipates the secondary waves so as to produce acoustical quality in the room. A permanent material of this kind is highly desirable, as it reduces the fire hazard, is more durable, and makes possible better architectural treatment of the interior of the room. It should be noted also that the square meter of audience has a high coefficient of absorption. This accounts for the distinct difference in the acoustics observed when a hall is empty and when filled with people.

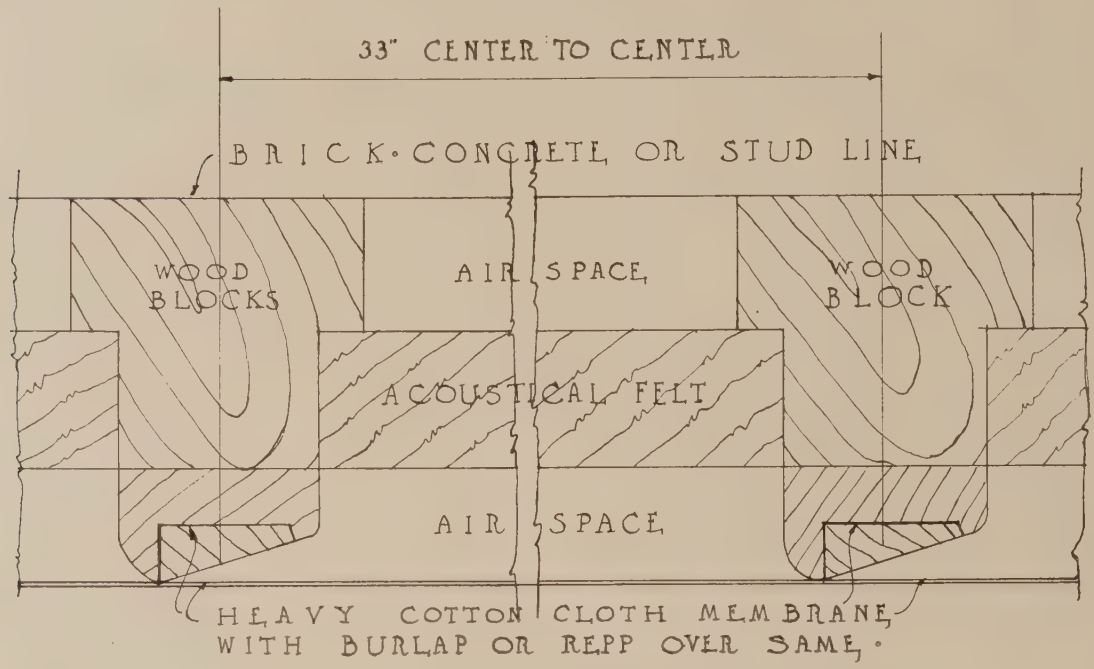
Reflecting Surfaces. — Very few school assembly halls are equipped with upholstered chairs. This is a drawback to good acoustics, as the wooden seats and backs are severe reflectors of both the direct and secondary sound waves. Likewise wood and concrete floors and glass are high reflectors. Therefore, whenever it is possible, the windows should be draped with heavy curtains and the aisles and passages should be covered with a carpet or with linoleum. Ceiling lights to admit skylight or indirect illumination should be avoided; instead the ceilings should be paneled, with hair felt and rep installed within the panels.

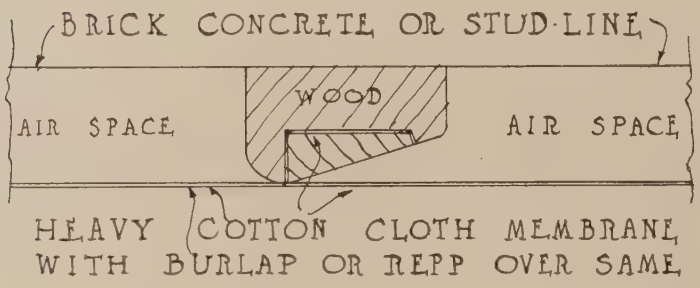
Wall Surfaces. — The shape of the room also has much to do with the formation of echoes. Long and narrow rooms are conducive to sound reflection and particularly so are rooms hemispherical in form, the latter serving very much in the manner of parabolic reflectors in the searchlight. A room more than 75 feet deep from the stage must have some means of focusing the sound waves to carry well beyond this point, as it has been found that beyond this distance the voice of the average public speaker is hardly audible. Of course, there is a danger in overpadding the interior of a room, so that on account of a lack of resonance sound becomes stifled. For this reason certain well-defined sections of the side walls should be of a material like plaster or brick which will reflect the secondary wave in such a way that it will arrive not later than one-fifteenth of a second after the arrival of the direct wave. This construction requires careful calculation and exact measurements, and the locations should be determined by some one expert in the study of acoustics.

Let it not be thought that what has been presented here is in any way a complete discussion of the subject. The writer has intentionally avoided a technical discourse which would involve not only physics but advanced mathematics as well.

Figure 279 shows the application of the hair felt and the rep. These materials should first be chemically treated to withstand fire and also be repellent to vermin. The rep should be dyed to the color desired for the finish tone; it should never be painted, as the paint fills the pores of the weave and forms a membrane over the material. This nullifies its purpose because the painted

[1] Bulletin No. 73 University of Illinois, and Kidder's *Architects' and Builders' Pocket Book*, 16th Edition.





METHODS OF APPLYING ACOUSTICAL FELT AND BURLAP OR REPP TO WALLS OF THE ASSEMBLY HALL.

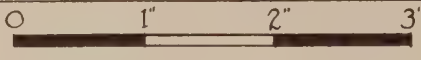


FIG. 279.

surface acts like a drum-head, and the waves cannot freely penetrate through or be absorbed by the fabric.

Organs. — In describing the modern assembly hall, one cannot omit mention of the organ any more than of the moving picture equipment. It should be borne in mind that even though an organ is not possible at the time of building the school and the assembly hall, there is no reason why the space and provisions for a future installation should not be allowed. It costs a community many times more to be lacking in vision than it ever does to spend freely with a clear vision of future needs. Good music, next to eloquence, will do more to stir humanity to right living and right action than any other force; it should be encouraged to the fullest extent, especially during the formative period of young manhood and young womanhood.

During the study and deliberation of the general problem, and particularly that of the assembly hall, an expert in organ installations should be consulted regarding the size of an organ most appropriate for the volume of the room, and the other necessities, such as space and size of pipes, bellows, fan, motor, etc. A word may not be amiss to call attention to the archaic use of false pipes for decorative effect. Usually the display is cumbrously done and seems to proclaim the vanity of some one in authority. Unless very cleverly constructed and so arranged as to convey the impression of a sunburst accenting an axis of the room, it is far better taste in design to substitute a simple decorative plaster grille which will provide openings for the sound to pass through. It is then possible to have echo pipes in different sections of the room. The cost of things constructed in good taste is usually less than that of mere showy and decorative features.

Quietness. — The assembly hall, like the library, should be located where quietness will prevail. It is the ordinary thing to place the boiler room, the fan room, or the cafeteria under the assembly hall. It is really the worst place to locate them, both for safety to the audience and for the full and satisfactory use of the room. The discomfort occasioned by straining to hear a speaker, or to listen to a musical or dramatic entertainment, destroys the possibility of wholesome pleasure. No excuse can be found for architects, and especially engineers, who will negligently overlook the necessities of locating the mechanical installations where they will function to the desired efficiency, and at the same time operate without the world knowing it. Boards of Education and the public are fast realizing that it sometimes costs a little more to have ideal conditions, but if they are made acquainted with the facts in time, they generally accede to the requirements. On the other hand, preliminary study and premeditation very often will bring the cost of good conditions below that of permanently bad conditions. Boiler rooms should be located in isolated buildings or in wings where they may be built entirely of fireproof materials such as masonry or concrete. Cafeterias likewise may better be located in separate buildings or in such part of the main building that no odors from the kitchens can permeate the school.

Moving Picture Booth. — To have good pictures requires not only a good machine, but a booth so constructed that the machine is not handicapped. (See Figure 280.) First of all, the booth should be solidly built, and the floor should have such rigidity as to obviate machine vibration, which makes the pictures dance and is harmful to the eyes of the observer. The vertical and horizontal axes of the picture rays should strike the center of the screen. This adjustment necessitates placing the booth, and especially the opening for the moving picture rays, directly on a line at right angles with the center of the screen. If the booth is at a high elevation, the screen should be tilted so the rays will strike it at right angles or nearly so. The screen should be rigidly fastened to prevent movement. When a gridiron is included in the stage equipment, it is possible to have the screen constructed of metal lath and plaster applied to a frame of channel and angle iron construction. The space for the picture should be painted an ivory white with a black border outside the limits of the rays, serving as a contrast to give distinctness to the picture.

Equipment and Current. — The equipment should consist of a good moving picture machine and a stereopticon lantern. If possible, the booth should also contain a spotlight for use during dramas and " skits " staged by the students. Light from alternating current is not as steady or as brilliant as that supplied by direct current. Where the latter is not available from the street service the motor generator set in the physics laboratory should supply the current. As a matter of good engineering, the current should be supplied from that source anyway.

Construction. — All fire ordinances require that moving picture booths shall be constructed of fireproof materials such as concrete, brick, or, as is generally used, wood sheathing covered with No. 26 gauge galvanized iron, locked-seamed for walls, floors, and ceilings. All doors, door frames, and shutters should be of metal, or be metal covered, and the shutters for the rays should be suspended by cotton strings attached to counterweights so that a flash of fire will burn the ties of string, allowing the shutters to close tight. All doors to the booths should close automatically and be kept closed during a performance. A metal film box which can be tightly closed should be provided in which to store the films within the booth. The combustion of a film is so rapid and intense that

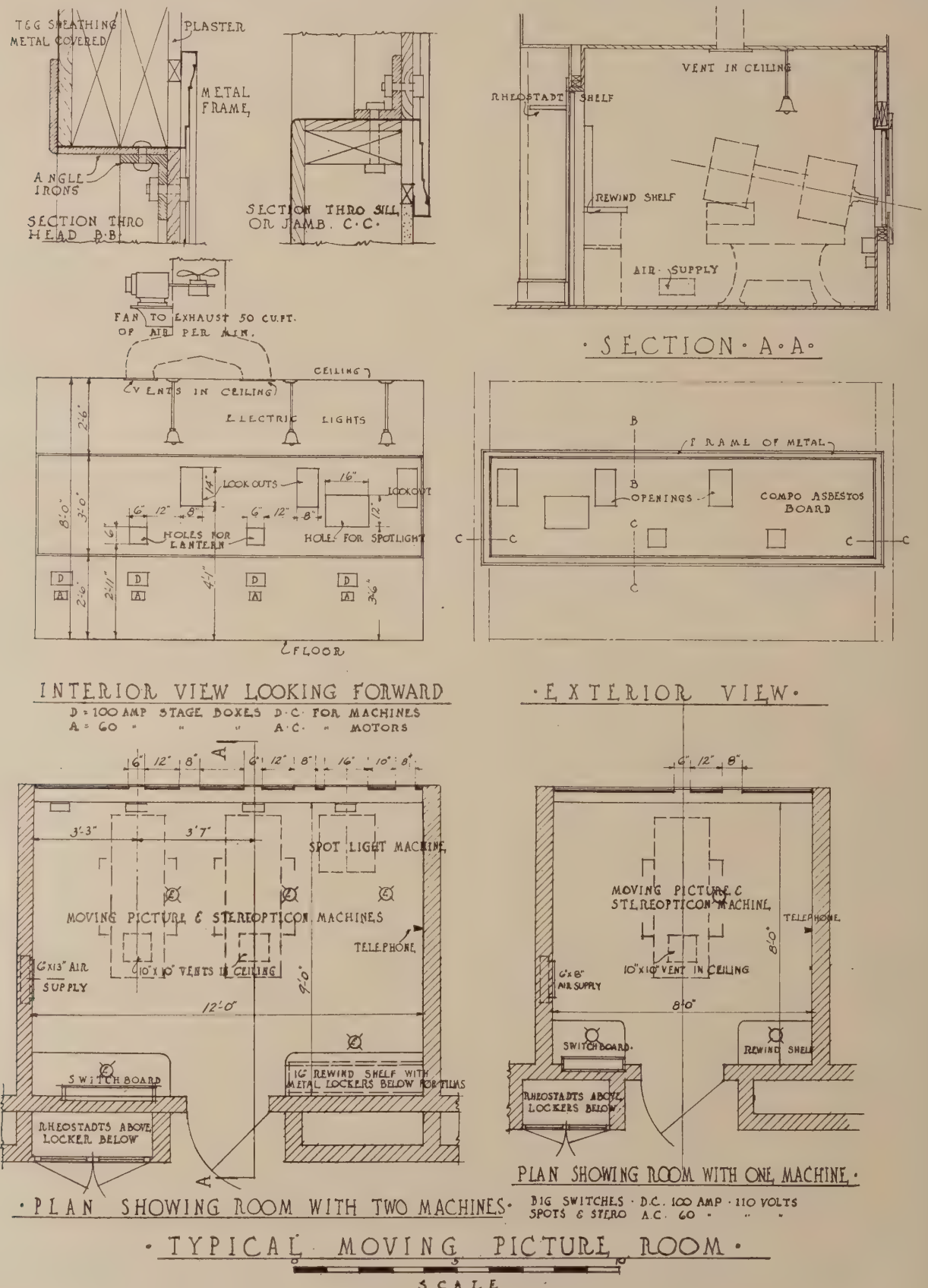

T&G SHEATHING METAL COVERED
PLASTER
METAL FRAME
ANGLE IRONS
SECTION THRO HEAD B-B
SECTION THRO SILL OR JAMB C-C
FAN TO EXHAUST 50 CU.FT. OF AIR PER MIN.
VENT IN CEILING
RHEOSTADT SHELF
REWIND SHELF
AIR SUPPLY
SECTION A-A
CEILING
VENTS IN CEILING
ELECTRIC LIGHTS
LOOK OUTS
LOOKOUT
HOLES FOR LANTERN
HOLE FOR SPOTLIGHT
FLOOR
FRAME OF METAL
OPENINGS
COMPO ASBESTOS BOARD
INTERIOR VIEW LOOKING FORWARD
D = 100 AMP STAGE BOXES D.C. FOR MACHINES
A = 60 " " " A.C. " MOTORS
EXTERIOR VIEW
SPOT LIGHT MACHINE
MOVING PICTURE & STEREOPTICON MACHINES
TELEPHONE
6"x13" AIR SUPPLY
10"x10" VENTS IN CEILING
SWITCH BOARD
16 REWIND SHELF WITH METAL LOCKERS BELOW FOR FILMS
RHEOSTADTS ABOVE LOCKER BELOW
MOVING PICTURE & STEREOPTICON MACHINE
10"x10" VENT IN CEILING
6"x8" AIR SUPPLY
REWIND SHELF
RHEOSTADTS ABOVE LOCKERS BELOW
PLAN SHOWING ROOM WITH ONE MACHINE
PLAN SHOWING ROOM WITH TWO MACHINES
BIG SWITCHES D.C. 100 AMP 110 VOLTS
SPOTS & STERO A.C. 60 " "
TYPICAL MOVING PICTURE ROOM
SCALE

FIG. 280.

Mr. John J. Donovan, Architect, and Mr. Henry Hornbostel, Consulting Architect.

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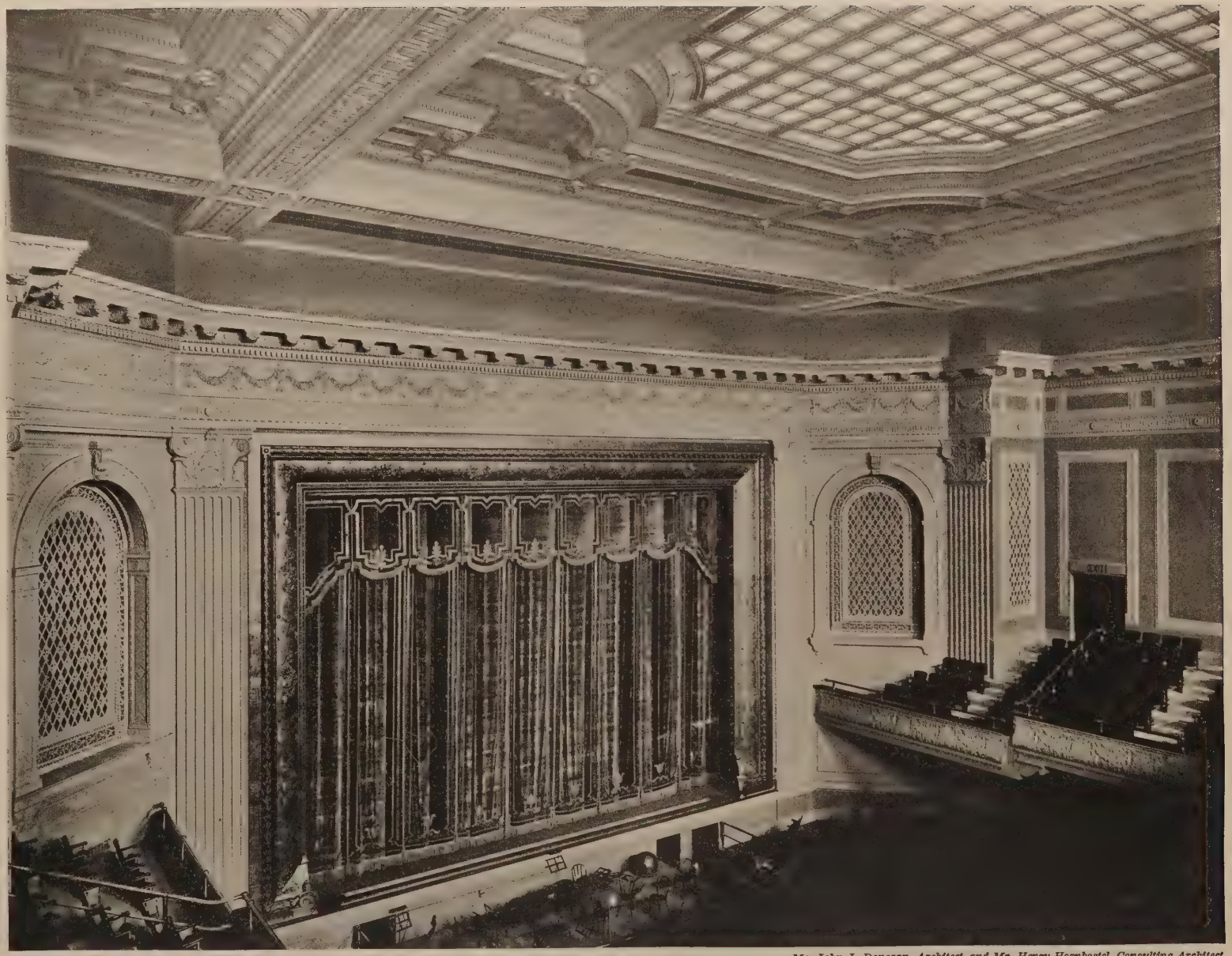
FIG. 281. — REAR OF THEATER, AUDITORIUM, OAKLAND, CALIFORNIA.



Mr. John J. Donovan, Architect, and Mr. Henry Hornbostel, Consulting Architect.

FIG. 282. — FRONT OF THEATER, AUDITORIUM, OAKLAND, CALIFORNIA.

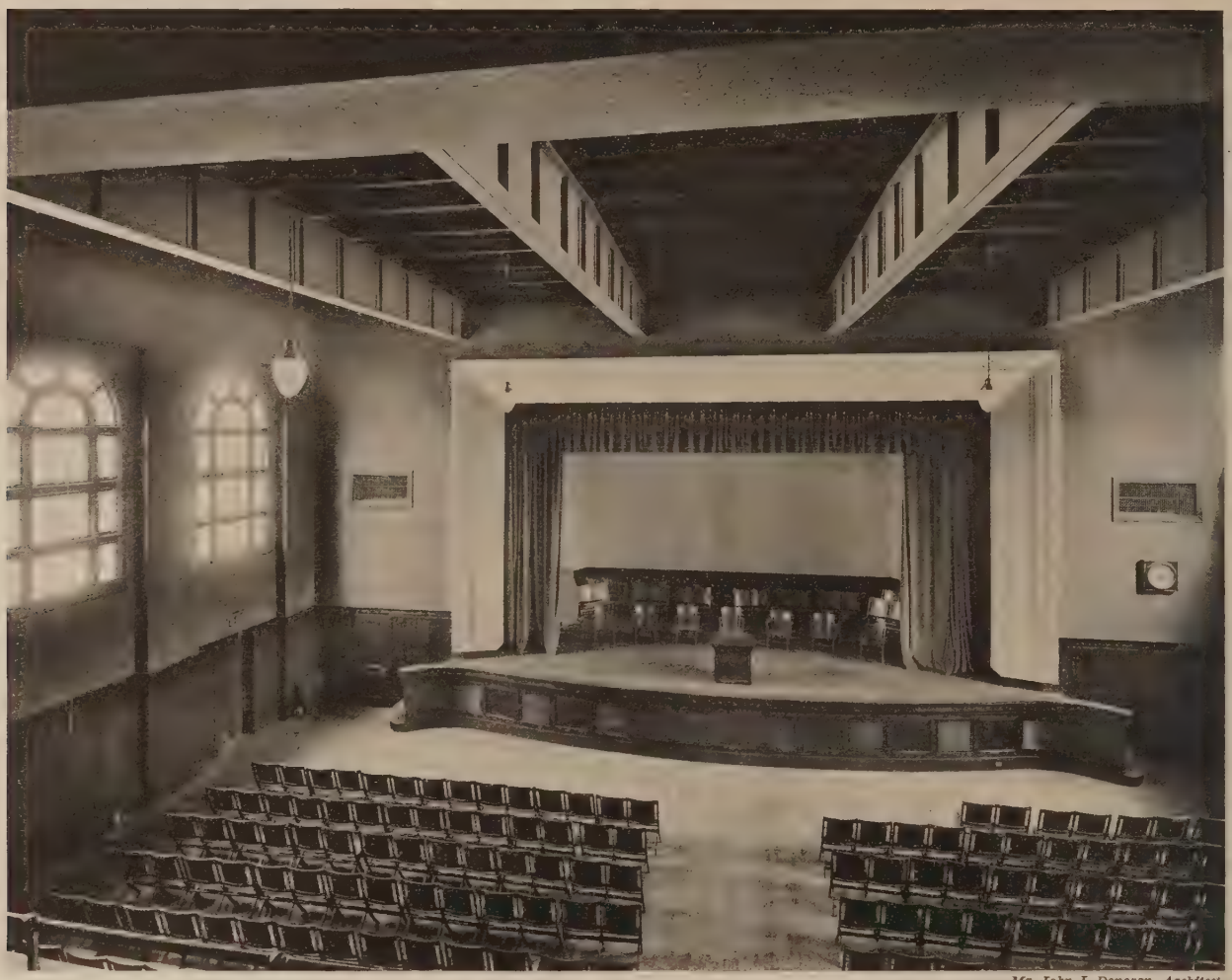
FIG. 283. — GROVER CLEVELAND HIGH SCHOOL, ST. LOUIS, MISSOURI. *Mr. Wm. B. Ittner, Architect.*

the operator seldom has time to escape should one catch fire while he is operating the machine. This film box may contain the rewinding machine so often needed in a much used picture booth. Without fail, the booth should be provided with a fireproof vent flue having a minimum cross sectional area of 50 square inches. It is best to locate this flue right over the machine and have it lead directly to the outdoor air. A fireproof inlet supplying 30 cubic feet of air per minute should also be provided for ventilation, so that the operator will not expose the audience to the danger of fire and panic by opening the door for ventilation when the booth becomes heated by the machine light. A signal button and buzzer in the booth and on the stage should be provided so that a lecturer may direct the changing of stereopticon slides. An inter-communication telephone system between the stage and the booth is desirable, and the expense is inappreciable compared to the convenience.

The construction of the front wall of the moving picture booth as shown in Figure 280 should be observed, as it is the most practical method found by the writer. The asbestos board is not secured in place until the picture machine is properly located with relation to the curtain and then the openings in the asbestos board are neatly formed. This asbestos board is about $\frac{3}{4}''$ thick and should be fastened so it can be easily removed in order that new machines may be correctly placed with relation to the curtain.

Lighting and Illumination. — If at all possible, the assembly hall should be well provided with good, natural lighting for the hygienic effect of the sun's rays in purifying the room. In fact, as we have previously said, all rooms in a school building should, if possible, have the benefit of the cheerfulness and natural warmth of sunshine.

The windows should have opaque shades operated within slides so that the room may be darkened for the use of moving pictures and stereopticon views. The method is quite fully described in the chapter on Physics. Heavy drapes or curtains will be found advantageous for the acoustical quality of the room, as well as for decorative purposes. Under " Electric Wiring and Illumination " the lighting of the auditorium will be described fully. However, the writer favors the semi-direct method, as it is more cheerful than the indirect and costs considerably less. On the other hand, direct lighting should be avoided, as the glare is decidedly tiring, and painful after a very short time. Either all fixtures should have double service, or certain fixtures should be wired to separate street service lines in order to have light, should the main service to the building fail for any reason. This is a precautionary measure that ought to be adopted in halls of large seating capacity.



Mr. John J. Donovan, Architect.

FIG. 284. — AUDITORIUM, CLAWSON SCHOOL, OAKLAND, CALIFORNIA.

One of the short-sighted regulations of many ordinances is the absurd size required for exit light boxes. They are unnecessarily large and out of keeping with the surrounding details. There is no reason why good judgment and consideration for proportion should not prevail in safety measures as in other matters. Exit lights should be placed over every exit and kept lighted during the occupancy of the room whenever the room is darkened.

Aisles. — The building laws of nearly all cities agree on the following as to the width of the aisles:

All aisles having seats on each side shall not be less than three feet wide where they begin near the stage and shall be increased in width towards the exits in the ratio of $1\frac{1}{2}''$ to 5 running feet. Aisles having seats on one side only shall not be less than two feet wide at the beginning and increase in width $1\frac{1}{2}''$ in 10 running feet.

Ordinances further require that all seats except those contained in boxes shall not be less than $32''$ back to back, measured in a horizontal direction. No seat in the auditorium or theater shall have more than six seats intervening between it and an aisle.

The above has been taken literally from *Building Ordinances Controlling the Construction of Auditoriums and Theaters*, which the construction of school auditoriums should follow.

Exits. — All assembly halls should have more than one means of exit. Exits should be arranged on the front and sides if possible as well as at the rear or entrance. This arrangement will give a sense of security which is important in the elimination of panics. Steps of any kind should be avoided either at exits or in any passage or aisle leading to the exits. Openings $5'\ 0''$ wide with double doors opening outward and operated with panic bolts should be provided for every 250 seats up to 1000, and then one for every 300 seats additional.

Painting and Decoration. — In order that harmony should prevail, the color scheme of the assembly hall

FIG. 285. — JUNIOR HIGH SCHOOL, TRENTON, NEW JERSEY. *Mr. Wm. A. Poland, Architect.*

should receive careful study. Unlike a theater, it is not adapted to a wide range of decorative ornament and free use of color. On the other hand, somber tones are likely to reflect melancholy, which is entirely out of keeping with the buoyant spirit of the students. The room has so many uses that no particular one should control the color scheme. Consequently, any light, cheerful coloring will usually be found appropriate. The chairs, curtains, hangings, and especially the scenery for the stage, should be selected so as to produce a general harmonious effect. The usual method is for the architect to select colors for the walls, ceilings, etc.; the purchasing agent selects the chairs and hangings; the principal selects the scenery; and the final result is a free-for-all, everlasting clash in the general scheme. Like everything else in the study of the plan, there should be collaboration and good team-work throughout; then not only harmony but happiness will prevail.

The assembly hall is the ideal room for a terse inscription which will attract the students' attention and lead to thoughts of the higher purposes of life. A well-chosen epigram often will do more to displace frivolity with earnestness and seriousness than a full course of lectures on self-efficiency. Likewise, the intellectual enrichment diffused by a fine mural painting is immeasurable. And there is no spot in the entire community where it can be observed by more people than upon the proscenium walls of the school auditorium. Here, again, is the opportunity for vision. Even though the available funds will not permit of a mural painting at the time of constructing the building, there is no excuse for not arranging space for such a future acquisition. The country is alive with fine young artists fully capable of producing wonderful visions of inspiration, who are glad to have the opportunity to demonstrate their ability and give life to their conceptions. A slight investigation will bring to light what may be accomplished at a very small expense. In order to avoid hasty action in the selection of the man and in choosing the subject, it is probably far better to have this piece of work done some time after the building is completed. Also, the artist should never be rushed in his work. For if done at all, it should be done well, as it is to be done for all time. Nothing is so disgusting as a pretentious or badly executed mural painting. A painting is indicative of the intelligence and skill of the painter, but it is also a measure of the taste and intelligence of the client, and in a school building, of the community.

Mr. Edward Stotz, Architect.

FIG. 286. — SCHENLEY HIGH SCHOOL, PITTSBURGH, PENNSYLVANIA.

Mr. A. F. Hussander, Architect.

Fig. 287. — Assembly Hall, Carter H. Harrison Technical High School, Chicago, Illinois.

Mr. A. F. Hussander, Architect.

FIG. 288. — CARTER H. HARRISON TECHNICAL HIGH SCHOOL, CHICAGO, ILLINOIS.

Messrs. Perkins, Fellows & Hamilton, Architects.

FIG. 289. — ASSEMBLY HALL GYMNASIUM, EDWARD S. BRAGG SCHOOL, FOND DU LAC, WISCONSIN.

Messrs. Perkins, Fellows & Hamilton, Architects.

FIG. 290. — ASSEMBLY HALL, LINCOLNWOOD SCHOOL, DISTRICT #75, EVANSTON, ILLINOIS.

FIG. 291. — OLIVER SCHOOL, LAWRENCE, MASSACHUSETTS.

Mr. James E. Allen, Architect.

Messrs. Guilbert & Betelle, Architects.

FIG. 292. — SOUTH SIDE HIGH SCHOOL, NEWARK, NEW JERSEY.

FIG. 293. — PARKERSBURG, WEST VIRGINIA.

Mr. Frank L. Packard, Architect.

CHAPTER XVII

THE MUSIC DEPARTMENT

By Glen H. Woods, A.A.G.O., *Director of Music School Department, Oakland, California*

I. Elementary Schools. II. Intermediate or Junior High School. III. Senior or Regular High School. IV. Assembly Hall. V. Vocational Music. (1) Equipment. (2) Office and Library. (3) Acoustics and Noise Deadening.

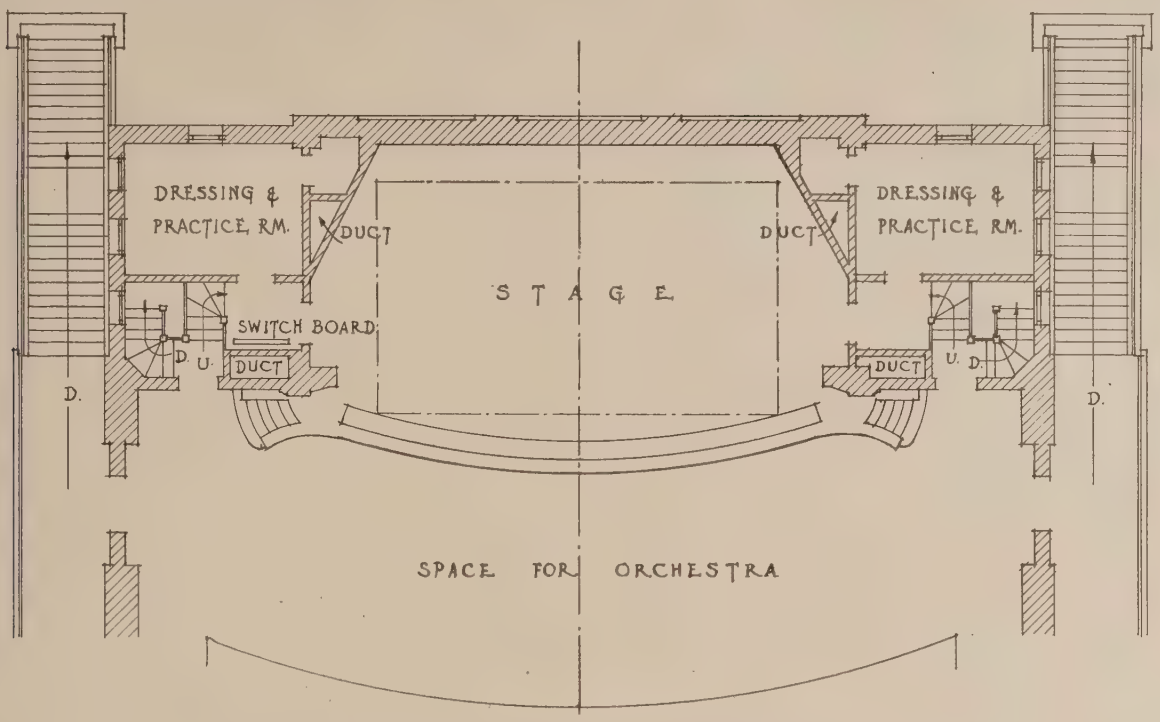
Elementary Schools. — On account of the rapidly increasing interest in the study and teaching of instrumental and choral music in the public schools, this division of the school organization requires careful consideration in the plan of the new school building. Two phases should be considered in the elementary school: first, small rehearsal rooms about 10′×12′ in which private individual instrumental instruction may be given; and second, the stage of the assembly hall, which should be sufficiently large to accommodate an ensemble rehearsal of all the players in the school. When assembly halls in elementary schools are equipped with movable chairs, it is possible to use them for other activities besides convocations and assemblies. Consequently, whenever the stage is too small, it is possible to use the floor for the rehearsals of the band and orchestra, and each player may have sufficient space so as to be seated comfortably and have enough elbow room to play without interference from his neighbor. Fixed audience seats placed close to the stage eliminate the use of the floor for rehearsals, and the stage is the only resource. Therefore, it is advisable to keep in mind the many uses to which the stage and floor may be assigned, and one of the most valuable uses is for orchestral concerts and rehearsals. In order to seat an orchestra of 30 pieces, the stage should be at least 32 feet wide by 17 feet deep. Figure 294 shows the seating arrangement of the players and the areas required for each group.

The Clawson Elementary School, Oakland, California, illustrated on pages 91, 332, is a good example of a model elementary school with excellent appointments for instrumental and orchestral instruction. The stage is elevated to a height of 4′ 0″ above the floor and is sufficiently large to accommodate an orchestra of 30 pieces. The small dressing rooms adjoining the stage are used for giving individual instrumental lessons, and when well lighted, ventilated, and far removed from the study classrooms, as in this case, they serve well for this purpose. The acoustical quality of this assembly room is almost perfect, as the walls of the room have a paneled wood wainscot about nine feet high and above this the masonry walls are covered with acoustical hair-felt and burlap. Also the ceiling is finished with wood beams and panels. It is an ideal room for an ensemble practice, there being no perceptible echoes even when only the players are present. No doubt this is due to the special treatment of the interior design.

In schools without assembly halls it is necessary to resort to the use of corridors or even to poorly lighted basement rooms. The serious danger of causing confusion in blocking the corridor in times of fire and panics makes it mandatory that in such cases temporary quarters like portable buildings should be furnished, pending the permanent assembly hall. Makeshift quarters are usually devoid of the proper natural and artificial lighting facilities, and the study of music requires both in order to save the pupils from eye strain.

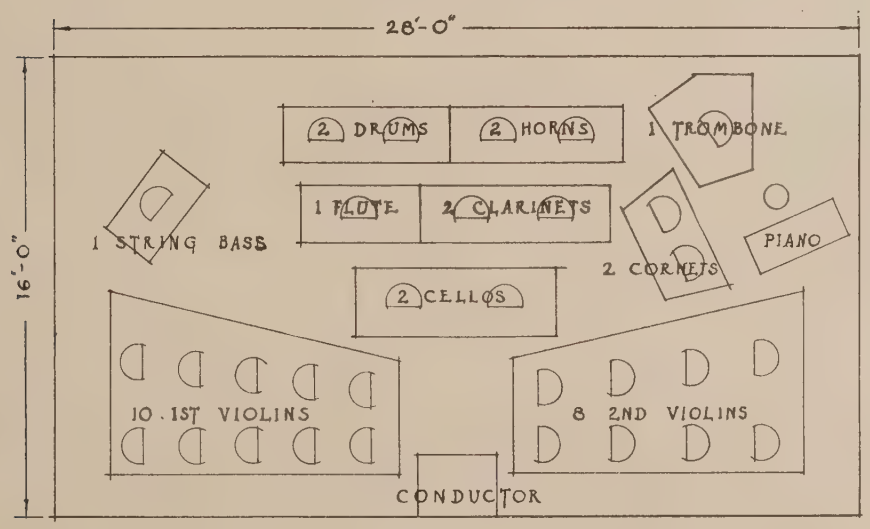
The Intermediate or Junior High School. — As the enrollment in the junior high school is much larger than that of the average elementary school, the musical activities are more intense, and consequently, the accommodations should be well thought out to provide for private individual lessons, orchestra practice, and choral classes. The small rooms, previously mentioned under *Elementary Schools*, and the stage of the assembly hall, will provide for the first two, and the average classroom can be used to good advantage for choral instruction where the classes are small.

However, in a school of this size and character, there should be a special music room which would have a seating capacity of about 150. This would then accommodate large choral classes for community singing. This room would relieve the assembly hall and serve for many other school purposes. The seating arrangement should be that of the amphitheater or " clinic " type so that the line of sight from each seat will focus upon the



ELEMENTARY SCHOOL ASSEMBLY HALL

SCALE 0' 5' 10' 15'

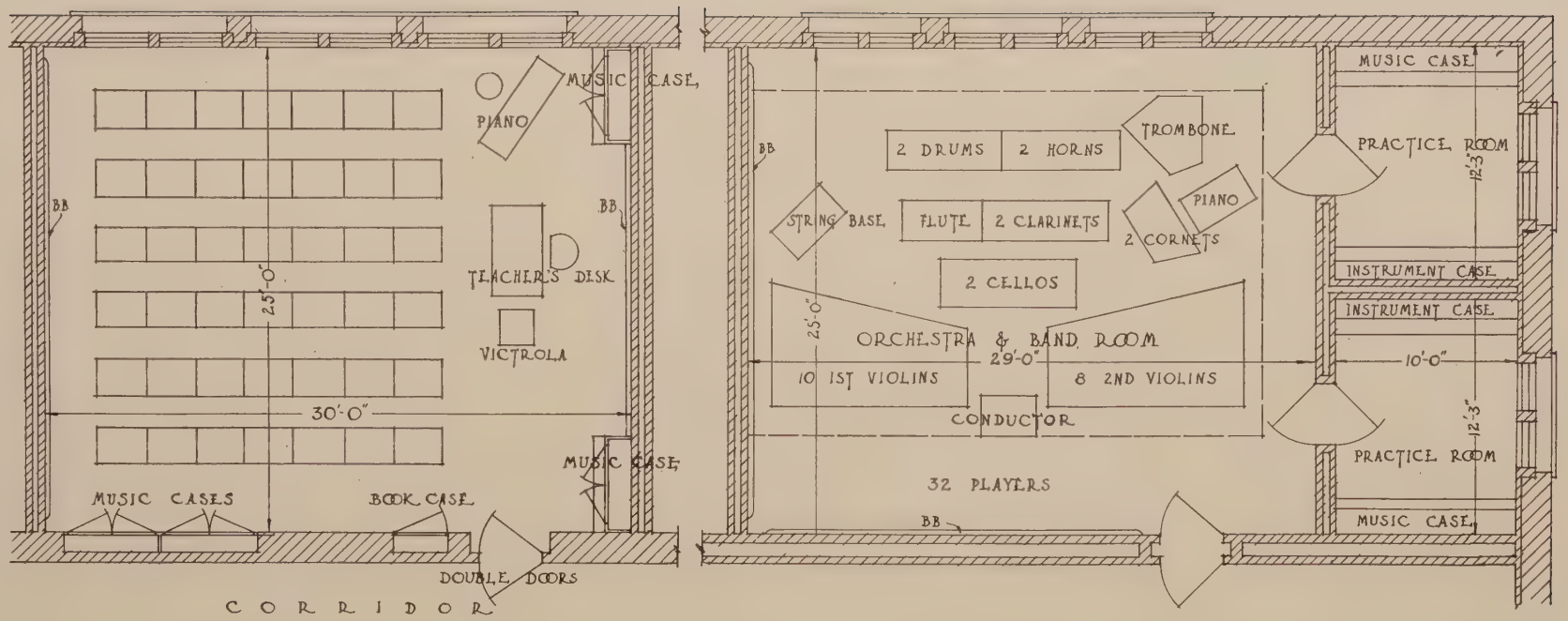


SUGGESTED PLAN FOR SEATING ELEMENTARY SCHOOL ORCHESTRA

32 PLAYERS AT 15 SQ. FT. = 450 SQ. FT.

SCALE 0' 5' 10' 15'

FIG. 294.

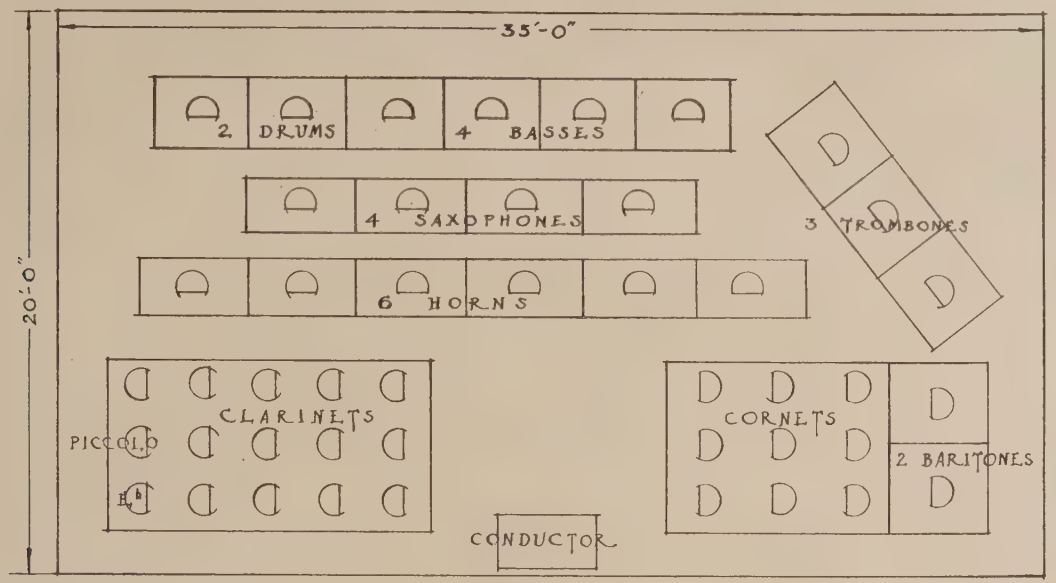


MUSIC ROOM FOR CHORAL, HARMONY & HISTORY FOR A JUNIOR OR SMALL HIGH SCHOOL.

BAND & ORCHESTRA ROOM FOR SMALL HIGH SCHOOL

SCALE
0' 5' 10' 15'

FIG. 295.

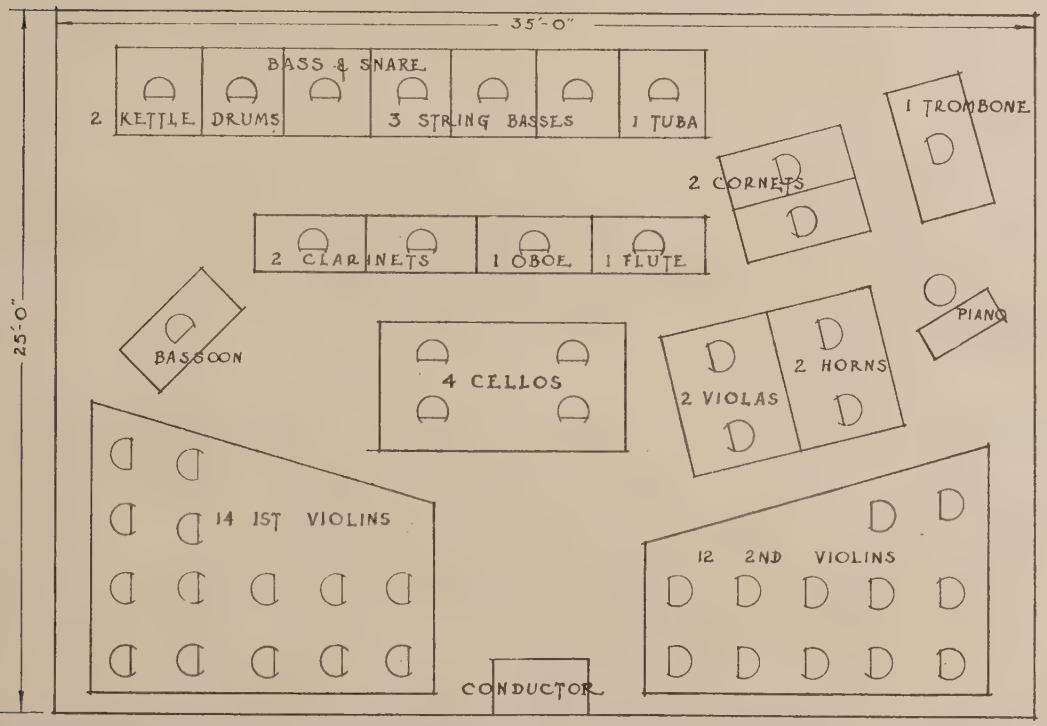


SUGGESTED LAYOUT FOR SEATING A BAND

45 PLAYERS AT 15 SQ. FT. = 675 SQ. FT.

SCALE

0' 5' 10' 15'



SUGGESTED PLAN FOR SEATING A HIGH SCHOOL ORCHESTRA

50 PLAYERS AT 15 SQ. FT. = 750 SQ. FT.

SCALE

0' 5' 10' 15'

FIG. 296.

instructor. With the seats elevated on steps or on a sloping floor, each pupil can be seen by the teacher, and the tone of each voice is not impeded or obstructed by the student in front. There are many objections to a level floor. A small stage or rostrum two feet high and about seven feet deep is very desirable. It should be about sixteen feet long so as to accommodate a piano and a victrola and to allow sufficient room for the teacher to move about freely. Music cases that may be securely locked could very well be built into the wall back of the rostrum, forming a paneled wainscot. These cases should be deep enough (about 15 inches) for books, records, and octavo music. For instrumental instruction, the plan of the elementary school should be increased to include more small rooms for individual instruction. For orchestral practice, the stage should be large enough to seat at least fifty players, that is, there should be a floor area of about 750 square feet, which allows 15 square feet per player. A stage 35 feet wide and 25 feet deep is just about adequate to meet these requirements. (See Figure 295.)

The intermediate school should have a special teacher in charge of all music work, having a small room set apart for a combination office and music library. This should be provided with wall cases for the storage of all kinds of music, records, and song books.

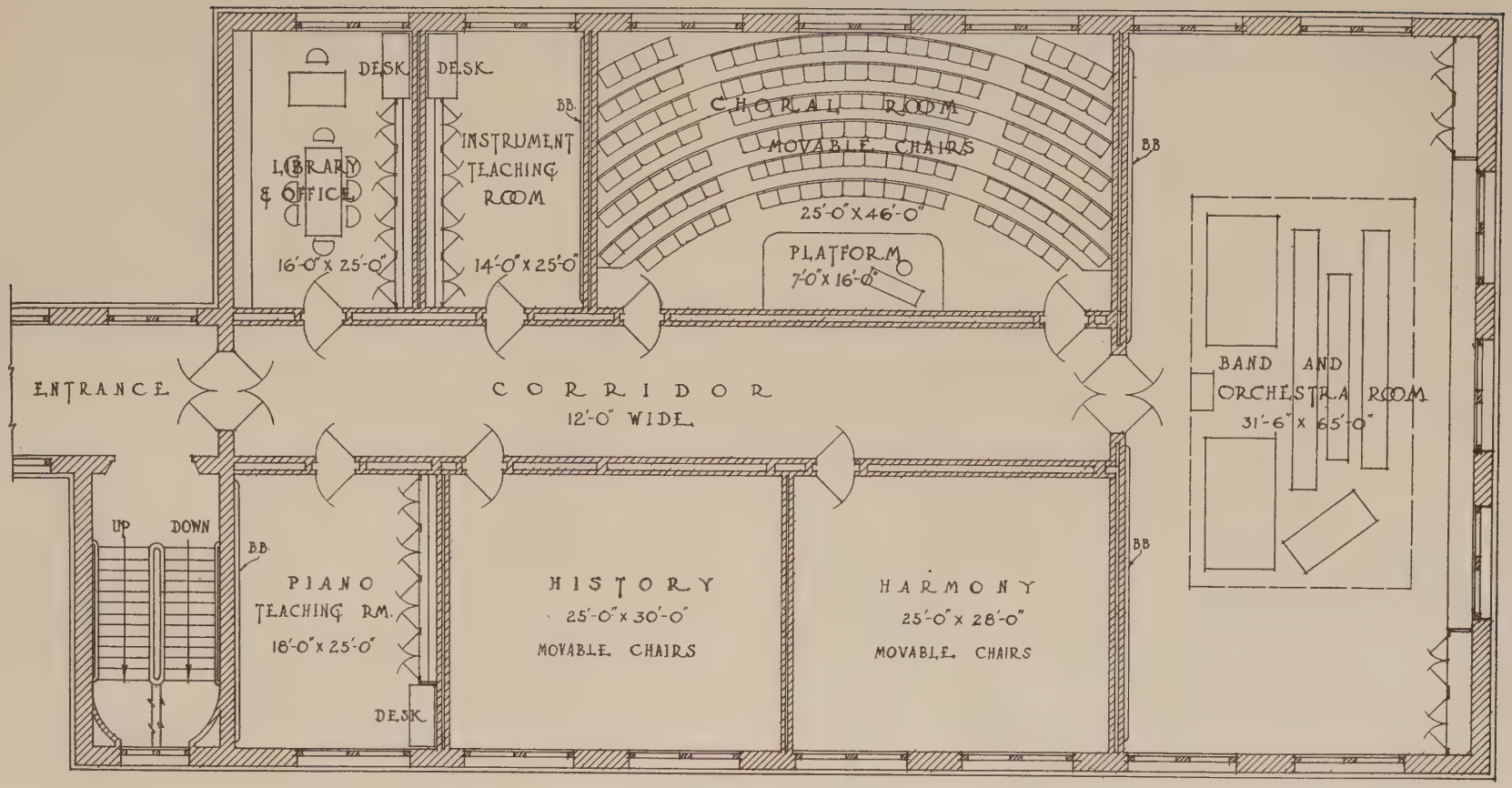
Senior or Regular High Schools. (See Figures 295, 296, and 297.) In the last five years the development of instrumental music in the high schools has met with such favorable approval and has been so generally accepted in all school systems that it is necessary to consider this phase of music instruction in connection with the construction of all new high schools. The average large high school will offer as electives in its curriculum, choral, harmony, and history; band, and orchestra; and individual instruction on all instruments, including the piano. Where the choral class is small, the average classroom accommodating thirty to forty pupils can be used. Inasmuch as the enrollment in the harmony and history classes is usually not large, these same classrooms can be used for such classes, provided there is sufficient space between the front row of seats and the wall to accommodate a piano and a victrola, besides the teacher's desk. (See Figure 295.) In rooms where harmony instruction is given regularly, the blackboards should be ruled with double staves of five lines, each $\frac{1}{4}''$ wide, with $1''$ spaces between the lines and $3''$ spans between the staves; the three sides of such rooms should be equipped with blackboards.

Where band and orchestra instruction is offered as a regular subject, it is advisable to have one room especially equipped for these organizations. If the same room is used for more than one phase of musical instruction, it is necessary to arrange the racks, chairs, and music for either or both of these organizations. For that reason the program should be arranged so as to concentrate the instrumental rehearsals in the afternoon. This will obviate the necessity of rearranging the room each time for these and other classes. While such a plan might indicate a rather expensive outlay, choice must be made between greater efficiency in handling such organizations with the minimum expenditure of time in getting ready for active work, or accepting the alternative of spending a large part of the lesson period in arranging the room for the rehearsal. The latter is a perpetual waste of the students' and instructor's time and is decidedly an economic loss.

This room should be well lighted, and the chairs should be arranged so that the backs of the students are turned towards the windows in order to have the light fall directly upon the music sheets. Figure 297 shows the desired arrangement. The orchestra and band room should be large enough to seat fifty players, and should have wall cases for the storage of instruments at either end and under the window stools. These cases should be specially designed to hold such instruments as the string-bass, bass-drum, cello, horns, trombones, violins, noncollapsible racks, etc. The last require considerable space for storage. Facilities should be at hand for quickly clearing the room, as it should be of a size very desirable for many of the school affairs.

The Assembly Hall. — Most of the assembly halls in even the modern high schools have little or no convenience for performances which require the accompaniment of an orchestra. Chorals given from the stage necessitate placing the orchestra on the floor in a way similar to that of the theater plan. Therefore, there must be sufficient space between the first row of seats and the stage apron so as to accommodate at least thirty players comfortably seated and in full view of the leader. Sixteen feet is none too large an allowance for this depth. (See Figure 294.) The space is always available for seats on skids or movable chairs which can be easily removed and stored away. The main point to keep in mind is that when once the fixed seats are fastened to the floor, this prohibits the use of the floor by the orchestra, and it is more difficult to have the fixed chairs removed than movable ones. Another important matter is to see that sufficient electrical base and floor receptacles are provided in the stage apron and in the floor from which extension cords may lead to the lighting fixtures on the music racks. Each music rack should be equipped with a semi-closed reflector similar to those used by theater orchestras.

Vocational Music. — Quite a few school departments in the country, believing thoroughly in music instruction,



MUSIC DEPARTMENT FOR A LARGE HIGH SCHOOL

SCALE
0' 5' 10' 15' 20' 25'

FIG. 297.

have established vocational courses which often require a special building, or at least a specially equipped music department. The preceding suggestions and the drawings shown will be found adaptable for vocational instruction with certain modifications, enlargements, and additional special rooms in order to have the school fit the community.

Equipment. — Music cases should be built to accommodate octavo music, 7″×11″; piano music, 11″×14″; orchestra music, 8″×12″; band music, 5″×8″ and 7″×11″; books, 5″×8″, 7″×11″, and 8″×12″, and records, 12″ in diameter.

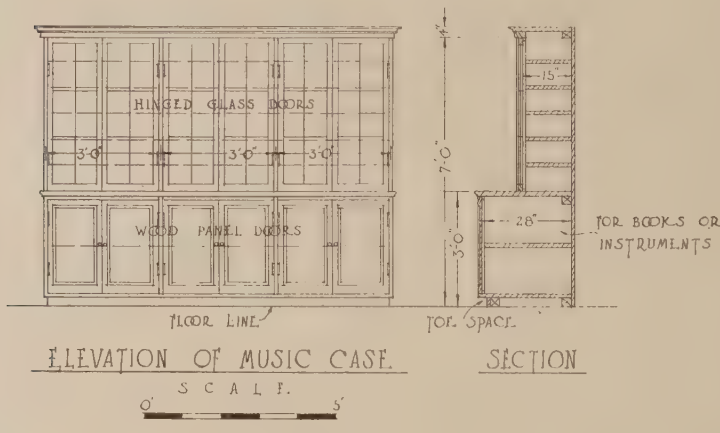


Fig. 298.

In constructing cases sufficient inside clearance should be allowed to facilitate ease in handling the music and to avoid tearing it when removing it or returning it to its place in the case. Open shelves 15″ deep, one foot apart, are preferable to partitioned sections that are too small. (See Figure 298.)

The best music rack for use at rehearsal on the stage or in the orchestra pit is a noncollapsible rack with a heavy iron-casting base with a pipe upright. The nickel collapsible and folding rack used by musicians as a portable rack is convenient but not strong enough to withstand the wear and tear of a rehearsal room, and is so light it is very easily turned over. The manual training department in any high school can easily make these noncollapsible racks at a moderate cost of about $1.00 apiece.

When pupils bring their own instruments to school, some place of safety must be provided for storing them during the periods when the pupil is reciting in his other classes. Such instruments as the string bass, tuba, cello, trombone, and saxophone are more or less clumsy and need special provision for their accommodation in order to protect them from injury by being knocked down or bumped into. Figure 299 is a suggestion for such instrument cases.

The chairs used for band and orchestra in the elementary schools should be plain, solid oak chairs with straight backs and flat bottom seats about 16″ from the floor. Such chairs will stand the wear and tear received in a rehearsal room and not be easily broken. The folding chairs, while more convenient for storing, are easily broken and are too unsteady and flimsy for the comfort of violin players. The same style of chairs can be used for high schools, except that the seat should be 18″ from the floor.

The pipe organ has been referred to in the chapter on *Assembly Halls*, but a word here will not be amiss. The school body and the public will find that the installation of a pipe organ is a great acquisition to any high school. A good two manual organ, fully equipped, will cost between six thousand and eight thousand dollars. The day is near at hand when the organ will be considered as essential to the equipment of the music department and the assembly hall as the lathe is to the machine shop.

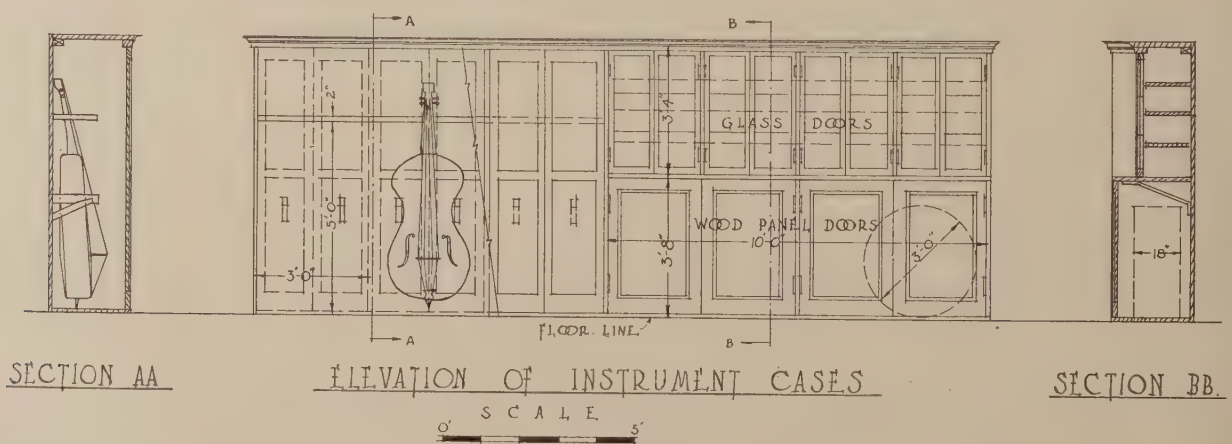


Fig. 299.

Mr. Wm. B. Ittner, Architect.

FIG. 300. — MUSIC ROOM, GROVER CLEVELAND HIGH SCHOOL, ST. LOUIS, MISSOURI.

Office and Library. — A music office and library is an economical combination of two essential features in any music department of a large high school. A clerk or office assistant can also serve as the music librarian, and all books and music used in the school can be controlled and distributed from a central office.

Acoustics and Noise Deadening. — Rooms used for chorals, orchestra, band, and individual instrumental instruction should be specially treated by padding the surfaces of the walls and the ceilings with acoustical hair felt covered with rep or burlap. It will also be found helpful if the floors are covered with linoleum. The subject of acoustics is very fully covered in the chapter on *Assembly Halls*. It should be remembered that it is utterly impossible to teach or study effectively in music rooms unless the echoes and reverberations are reduced to the minimum. Likewise, it is important that the transmission of sound from one room to another should be carefully guarded against in the construction of the walls, ceilings, and floors of the building. Figure 297, in the chapter on *Assembly Halls*, shows how this may be done as effectively as building conditions will permit. Double doors are quite necessary between rooms, although there is a single soundproof door in use at the School of Music, Northwestern University, Evanston, Illinois, and in the music department at Yale University, which seems to answer the purpose quite well. These are matters which distinguish a good plant from a poor one, and no matter how adequate the scheme and plant may be, if the essential details for controlling the sounds and echoes within the rooms are not cared for, the educational results are bound to fall below the standards possible where favorable conditions prevail.

CHAPTER XVIII

PHYSICS AND CHEMISTRY

By Arthur L. Jordan, *Head of Department of Science, Polytechnic High School, San Francisco, California*

I. *Science Department.* (1) Preliminary Note. (2) Intermediate School, Regular High School and Junior College. (3) Location of the Science Group Rooms. (4) Furniture. (5) Workshop. (6) Library. (7) Special Plumbing. (8) Dark Room Picture Projection. (9) School Camera. (10) Laboratory Breakage Fund.

II. *Physics.* (1) Lecture Room. (2) Storeroom for Lecture Table Apparatus. (3) The Laboratory. (4) Equipment. (5) Storerooms. (6) Dark Rooms.

III. *Applied Physics.* (1) Special Laboratories. (2) Laboratory for Mechanics, Strength of Materials and Hydraulics. (3) Steam and Gas Engine Laboratory. (4) Laboratory for Direct and Alternating Current Electricity. (5) The Machines. (6) Measuring Instruments. (7) Switchboards. (8) Lamp-Bank. (9) Apparatus. (10) Storerooms. (11) Lecture Rooms.

IV. *Chemistry.* (1) The Lecture Room. (2) Storerooms for Lecture Table Apparatus. (3) The Chemistry Laboratory. (4) Switchboards. (5) Laboratory Tables. (6) Balance Room.

V. *Applied Chemistry.* (1) Planning of Courses. (2) Technical Chemistry (for young men). (3) Household and Domestic Chemistry, the Chemistry of Foods (girls). (4) Lighting of Laboratories. (5) Technical Education for Adults, for Crippled Soldiers. (6) Lessons from the War.

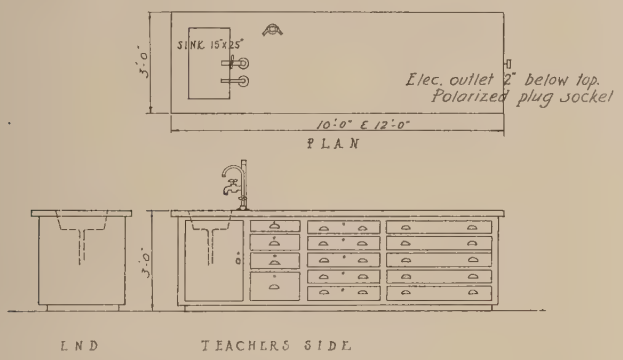
I. The Science Department. *Preliminary Note.*— No apology seems necessary in demanding for the science department a most important place in the plans for building an equipment of a high school. Science attained great prominence in world affairs before the war, and every one knows of the vital part which it played during the war.

The science department has two special relations to the community: first, the use of the projection apparatus (for fixed or moving pictures), the electric current for and the adjustment of which are most commonly a science department problem; second, the need of the community for certain special courses, as Assaying, Agriculture, Applied Courses in Electricity, Hydraulics, Mechanics, Strength of Materials, including Cement and Concrete (for boys), Biology, Physiology, Household Chemistry, First Aid and Nursing (for girls). These, in general, are not essentially for college preparation, but some communities believe very strongly in the preparatory courses, and the work should then be modified accordingly. The rooms needed for the department will be referred to as the "Science Group."

Certain assumptions are necessary: (1) That general science (or some other equivalent "First Year Science") is given in the first year, and we should consider whether it is a "required" or an "elective" subject. If the former, large classroom space and teaching force are necessary. (2) Chemistry and physics are usually given in the third or fourth years except where special courses like those mentioned above are given, in which case the following plan works well: At the end of the first year the students are divided into two groups, "College Preparatory" and "Non-College" or "Industrial." The former take a course in elementary physics of four periods (45 minutes each) per week during the second (sophomore) year, chemistry or biological work during the third year, and the completion of the physics (6 periods per week) in the fourth year. The latter are given a course in the second year (6 periods per week instead of 4) called "Practical Physics." This leaves the entire third and fourth years for the special courses referred to. (3) The above-mentioned three subjects with one other (say biology) form the more or less standard group of courses, the rooms for which constitute the "Science Group" mentioned above. One other room of the utmost use to the public as well as to the school is one intermediate in size between an ordinary science lecture room and the main auditorium, and holding from 150 to 250 people with a raised bank of tablet chairs. This is much better for meetings than the "study room" sometimes pressed into service. This room can be used for Science, and called the "large lecture room," its projection lanterns and lantern screen being useful to teachers of English, history, etc., as well as for public lectures, community singing, and similar meetings. (4) While the relative numbers of students of the two sexes may vary at different times and in different places, it may be assumed that the two are about equal in the "first year science,"

that there will be more girls than boys in the biological sciences and the reverse in the physical sciences.

Intermediate School, Senior or Regular High School and Junior College. — If the community decides to change the prevalent system (elementary school 8 years, high school 4 years), it can do so according to one of two or three plans. For example: elementary school the first six years, intermediate 3 years (7th–9th), high school 3 years (10th–12th), junior college 2 years (13th–14th). Following this plan, the work outlined below under heading "Applied Physics" and "Applied Chemistry" would come in the junior college, and the additional rooms, apparatus, and machinery required must be of the same character as those used in university work. Instructions cannot be given, as in English or mathematics, by simply employing a qualified instructor; nor can it be given with the science apparatus of the high school; and the cost of the additional equipment must be understood and provided for. (See paragraph on "Cost Estimates" later.)



SCIENCE LECTURE TABLE

FIG. 301.

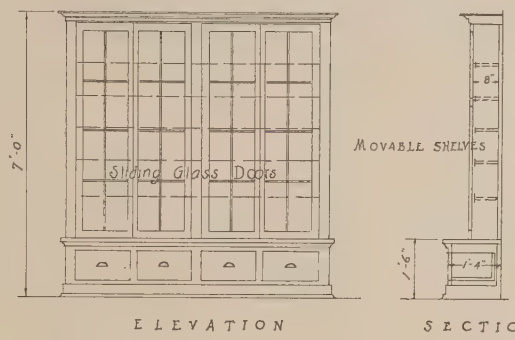
Location of the Science Group Rooms. — If the ground-floor story is high and well-lighted, this is the best location on account of its freedom from vibration. Vibration interferes seriously with accurate balance work in chemistry, with the use of the microscope in biology and all uses of delicate galvanometers in electricity.

If the floor is of cement, it should be smooth-coated and then be covered with a good grade of battleship linoleum. This will prevent the serious tiring of feet which is sure to occur; also the cold during winter, if uncovered cement is used.

In answer to the argument that the fumes from chemical processes will be objectionable if the laboratory is on the ground floor, it can be stated that experience shows that a good ventilating system with motor-driven exhaust or suction fan will discharge them through an outlet above the roof.

The first floor is, of course, next best, and it is far better to have the group all on one floor rather than to separate the rooms and have the discomfort of stair-climbing.

In a small high school one lecture room can be used for two sciences, as physics and chemistry, and the ideal location would be midway between the two laboratories. The only difference in equipment if the room is used for chemistry would be to have a somewhat deeper sink in the lecture table and a fume-closet



LIBRARY FOR SCIENCE BOOKS.

FIG. 302.

built near the front of the room. Forced ventilation will be treated later. In large schools separate rooms should be provided, as they are in continual demand for meeting places of various school activities.

Science Department Furniture. — Furniture for the department should be planned at one time, and it should be alike as far as possible. This facilitates interchanging, allows for expansions, etc., and produces flexibility. It may be classified into: (1) Standard (as stools and chairs, filing cabinets, some laboratory and lecture tables). (See Figure 301.) (2) Built-in, as sliding blackboards; lecture tables, chemistry laboratory tables and all other fixtures requiring plumbing or electricity; apparatus wall cabinets for physics, for chemistry, for biology; library for science books (see figure 302 for type of bookcase), etc. (3) Special, as bulletin boards, keyboards, display cabinets, etc. (4) Mill work, as cabinets for the ordinary 9×11 inch science binder — 60 shelves, holding 120 binders, which should be built in the walls, double and single direction boards, lantern-slide cabinets, tool cases for workshop, two kinds of wall cabinets, narrow and wide (with glass doors and movable shelves) which should be located in convenient places, and fastened to the walls after rooms are finished. Designs for these are given later.

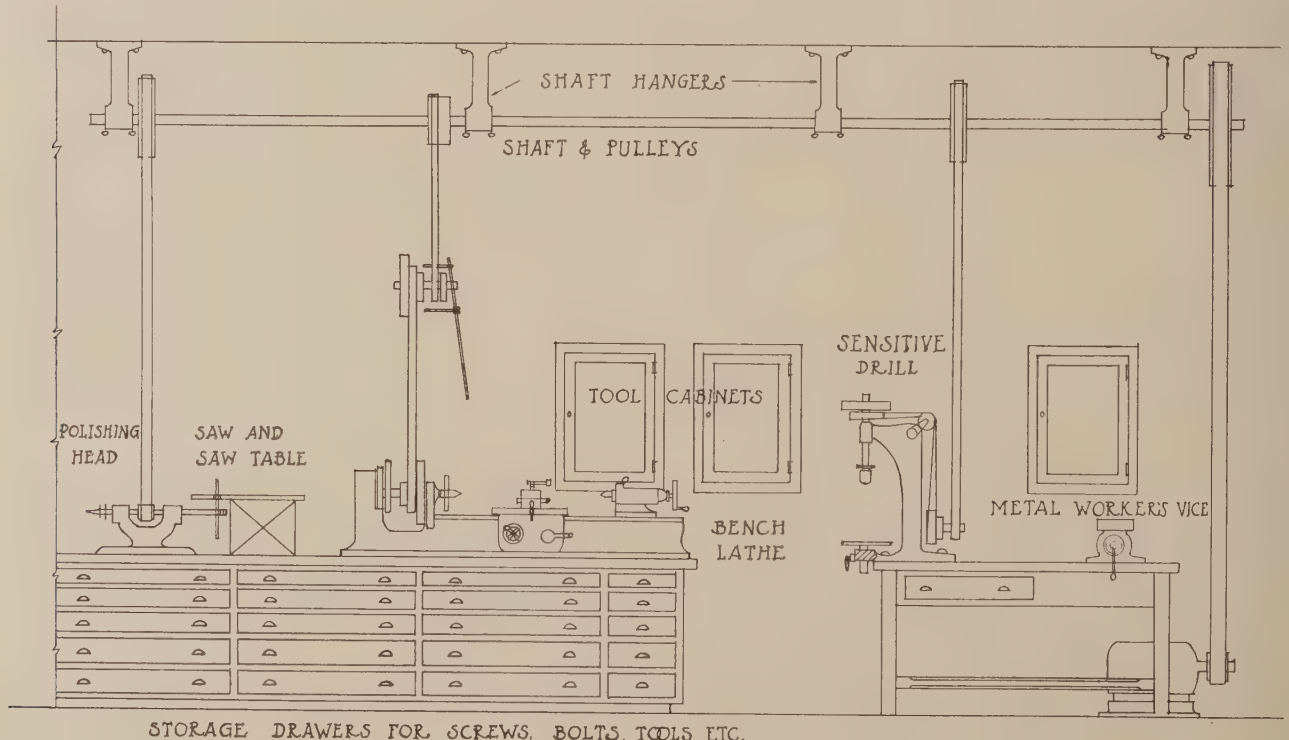
Science Department Workshop. — One small room should be fitted up as a workroom or shop (one end of a large store can be used). (See Figure 303.) A heavy bench with a vise and anvil is the first requisite; the second, a set of good carpenters' and metal workers' tools. Cases with good locks should be provided for them.

If the school has no machine shop or woodworking department, the investment of a few hundred dollars in a machinist's lathe, a wood lathe, a sensitive drill, and a "polishing head" (fitted with circular saws and saw-table), with the necessary shafting and driving motor, would certainly pay. This equipment provides for the repair of numerous pieces of apparatus and furniture, also for the building of new apparatus. The latter is not only a great economy, but also allows the progressive teacher a chance to keep his courses up-to-date with new experiments and to prepare material for popular science lectures and demonstrations.

Science Department Library. — Equal in importance to a set of mechanical tools is a collection of good reference books. In some cases it may be well to have all the science books in one place, provided with library tables (of glazed partitions), under the constant supervision of a teacher, but experience has shown that reference books are most useful when near at hand; hence it is usually better to have the physics books in the physics laboratory, those on biology in the biology laboratory, and so on. When the students' tables are apt to be covered with acids, as in chemistry, a wall-table for reference books should be provided. The preservation of these books is in the hands of the teacher.

An important question is that of providing funds for the renewal of books. A still more important one is the need for new books, which, in some cases (*e.g.* wireless telegraphy) as soon as they are published, render their predecessors obsolete. Closely related to this is the subject of subscriptions to the scientific papers and magazines. Books are somewhat behind the times, and a few good papers are absolutely necessary to keep the school up to date. In no line of human activity is there more rapid development than in the lines of applied science. The money for the above may be obtained from the general library fund of the school. Another possibility, especially for the magazines, is a voluntary subscription from the students taking the subject to which that magazine applies. The best plan, however, in most cases is to draw from the laboratory or breakage fund mentioned later.

Special Plumbing. Gas. — It frequently happens in science laboratory work that most of the students need



SCIENCE WORKROOM OR SHOP

Fig. 303.

bunsen burners at the same time. A large number of gas nozzles therefore should be provided and large-sized supply pipes (at least 1½ inch mains, and one inch feeders) should be run. The pressure should not go below 6 inches of water when the maximum number of burners are in operation. The *nozzles* should be of the same diameter ($\frac{5}{16}''$) as the tube of the standard bunsen burner, so they will take the same size rubber tubing; and a few fixtures for bat-wing gas flames should be provided. They are useful in bending glass tubing and for " objects " in the study of " Light." In some special cases (chemistry lecture table, blow-torch in shop, or gas engine supply) a larger nozzle ($\frac{1}{2}''$ to $1''$) is needed.

Water. — In chemistry, one sink should be provided for every two students; for physics, general science and biology, at least three sinks in each room are desirable. On all lecture tables there should be two faucets, one fitted with a $\frac{3}{4}''$ hose bibb. This is so that an aspirator can be used. In general, they should be high enough (not less than $16''$ above bottom of sink) to allow for tall jars being placed below them, and all supply pipes should have controlling valves below each sink. All supply pipes to the different floors should be equipped with controlling valves.

Hot Water. — A separate heater (for the few experiments requiring hot water) will usually cost less than the installation of plumbing for hot water at each sink; but this also depends upon the kind of heating plant for the building and the possibility of a constant hot water supply.

Photography. — Two or more sinks will be needed in each photographic dark room.

Compressed Air or Vacuum Piping. — For ordinary high school science work, experiments requiring compressed air or vacuum are very rare, and it would seem a waste of money to provide the plumbing for them. If advanced laboratory work is to be given, an air compressor is very desirable. The plumbing used in conjunction with it, as well as that for hydraulics, steam, and gas engine work is mentioned in Part IV, Applied Physics.

Darkroom Picture Projection (including moving pictures). — This subject involves the ordinary lecture rooms for all of the divisions of science, for history, English, modern languages, etc.; the room spoken of as the " Large Lecture Room " (seating 150 or more), Sect. 1, and the auditorium or assembly hall.

Opaque Curtains. — All rooms where direct sunlight can enter should have a set of translucent curtains for use during sunshine hours. In addition to these the rooms mentioned above should have a set of carefully fitted opaque curtains. It is true that for the projection of the commonly used transparent slides the room need not be very dark — and for younger students it should never be entirely so — but for the projection of opaque objects (reflectoscope) and for certain experiments in chemistry (as phosphorescence), and in physics (violet light, electric brush discharge), there must be some arrangement that permits it to be darkened completely.

Curtain Guides. — These should be a part of the contract for the building, and the architect should see that there is ample clearance (*i.e.* the slot in which the curtain runs should not be narrow), that there is plenty of overlap ($2\frac{1}{2}''$ to $3''$), and that the roller is boxed in at the top and the guides closed at the bottom. These guides can be made of metal and an insert of bone or hard rubber provided so that the cord which raises or lowers the curtain will not be frayed by use. (See Figure 304.)

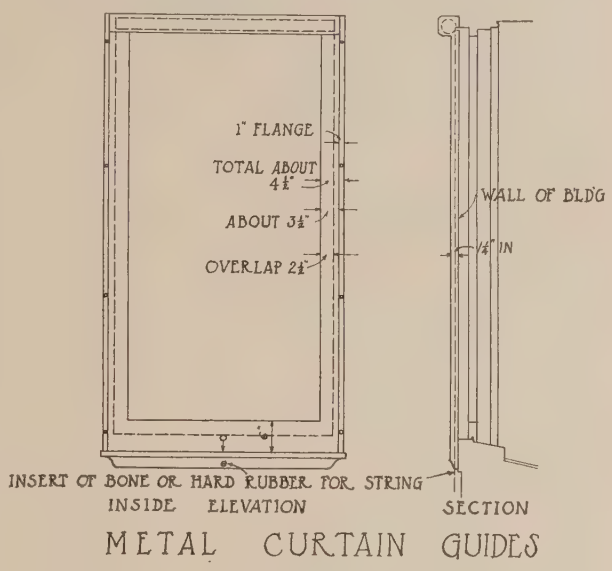


Fig. 304.

Ventilation. — If the room is darkened, ventilation by doors and windows is impossible, and if the building has no ventilating system forced ventilation must be resorted to for this room. Any one who has attended " picture shows " in poorly ventilated theaters will recall the ill effect of a large crowd added to the heat from the lantern. This is a good example of the general necessity for mechanical ventilation, as mentioned above. Its installation should be in the hands of a competent ventilating engineer, for the selection of the proper fan, the designing of ducts which will allow air to enter but no light, the preventing of the noise of the fan from interfering with the speaker, etc., are jobs for an expert.

Lanterns. — Lanterns using gas-filled incandescent lamps. These are suitable for small and medium-sized rooms and are primarily for slides, although some forms

can be used as "reflectoscopes." They may be attached to an ordinary electric lamp socket, having either direct or alternating current, and do not require an expert operator. That is, the lamp requires no attention until it is burned out, and then it is easily replaced by a new one (costing about $5 for a small lantern). One type of a double lantern having a pleasing "dissolving" effect can be bought (Bausch & Lomb Co.) for about $65.

Lantern Using Arc Lamp. — A lantern using an arc lamp for its illuminant is best for a large room (auditorium) and direct current is far superior to alternating. This requires from 7 to 14 amperes and special wiring is advisable. The cost for renewing the carbons is very little. It can be used for projecting the words or music of songs (if slides are properly made) in a fairly light room.

Reflectoscopes. — A small reflectoscope, which will show pictures slightly larger than post cards, cost (in 1915) with screen, $46.00; a larger one (also using a gas-filled lamp, but without screen) cost about $125.00. A very efficient reflectoscope, using an arc lamp and direct current of from 25 to 30 amperes, which will show 8″×8″ pictures, cost (without screen) $340.00. Special wiring is necessary for this type.

The lamp renewals of the first two, and the replacing of broken condensing lenses of the last, are very expensive, so the matter should be considered carefully before purchasing this form of projector.

Moving Picture Projectors. — The unquestioned value of the moving picture film as an aid to education makes it highly desirable to equip the assembly hall of the school with one good machine (*e.g.* Simplex, Powers, or Edison.)[1] If funds are not available a place at least should be provided for it, and later, an entertainment or other appeal to the community may supply the funds.

The projection booth should be fireproof and should otherwise conform to the insurance regulations. It is usually placed in the back of the gallery, as space can better be spared there than on the main floor. This booth is used for ordinary projection as well as for motion pictures.

Screens. —Where the lecture room is wider than it is long, the ordinary screen (cream tinted) is satisfactory; where the room is long, and also where the reflectoscope will be used, the "aluminum" screen (cloth covered with some special aluminum paint) should be installed.

For the auditorium, the best screen is the white plastered wall at the rear of the stage; but as the stage is likely to be filled with "scenery" it is well to have an additional screen on a spring-roller. This should be mounted on a frame and hung from pulleys so that the frame may be hoisted out of the way when not in use. The screen is held taut when in use by short cords attached to the lower corners of the screen with snap catches which engage with rings set in and flush with the stage floor. These not only prevent swaying (which spoils the pictures), but also allows the bottom of the screen to be pulled forward until it is *exactly at right angles* with a line from the center of the screen to the lantern lens. The plastered wall of course cannot be so adjusted, but if the lantern is not too high, the distortion is not very noticeable.

To sharply define the outline of the picture and at the same time correct any slight errors in adjustment, a flat black border should be painted around the edges of the screen and extended 3 inches inside of the outer border of the picture.

Electric Wiring and Current Supply. — For all but the small lanterns using the gas-filled lamp, a heavy current is necessary, and an outlet lock-box with fuses and switch should be installed at each place where a lantern is to be used. In a very large room (auditorium) two extra wires, for buzzer-signal or telephone, should be run from the stage to the operator's booth.

Current Supply. — Direct current is a necessity for all experimenting involving storage batteries, electroplating, elementary electrical laws, moving picture projections, etc., and is desirable for all projection lanterns using an arc lamp; so a reliable source of its supply should be provided. (An exception to the above statement is that the very latest invention of an extra high intensity gas-filled lamp makes it possible to run moving picture machines with alternating current; but the cost of bulbs for renewals makes them almost prohibitive for most schools.) In the rare case where 110 or 115 volt direct current street service is available, it may be run to the main distributing board and no provision need be made for alternating current except where special courses are given in that subject.

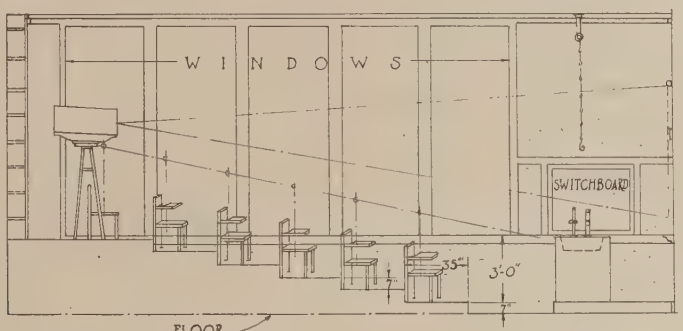
In the usual case, the street service is alternating and may be either single phase or polyphase. If both are within reach, so much the better. Some means of rectifying or changing this alternating current to direct must be used, and of all the various schemes employed,

[1] Many smaller and cheaper machines besides those mentioned are on the market, and they have two great advantages: — 1st, Having a gas-filled lamp for light-source, they allow the film to be stopped for some time without damage from heating. 2d, They are more portable and can be used in a small room from an ordinary lamp socket. The second point can be met, in some schools, by mounting the large projector on a carriage which can be wheeled about the building, and it can be used in small rooms by substituting a different objective lens and providing outlets for the heavy current (30 to 35 amperes) required. The large machines are more durable and usually give much better projection, besides being less likely to injure the film.

at present one stands out as far superior — a direct-connected motor-generator set of one of the standard makes, of from 5 horse power up, with its necessary attachments. This should be selected under the supervision of an electrical engineer, who should be furnished with data on the maximum demand to be made upon the machine.

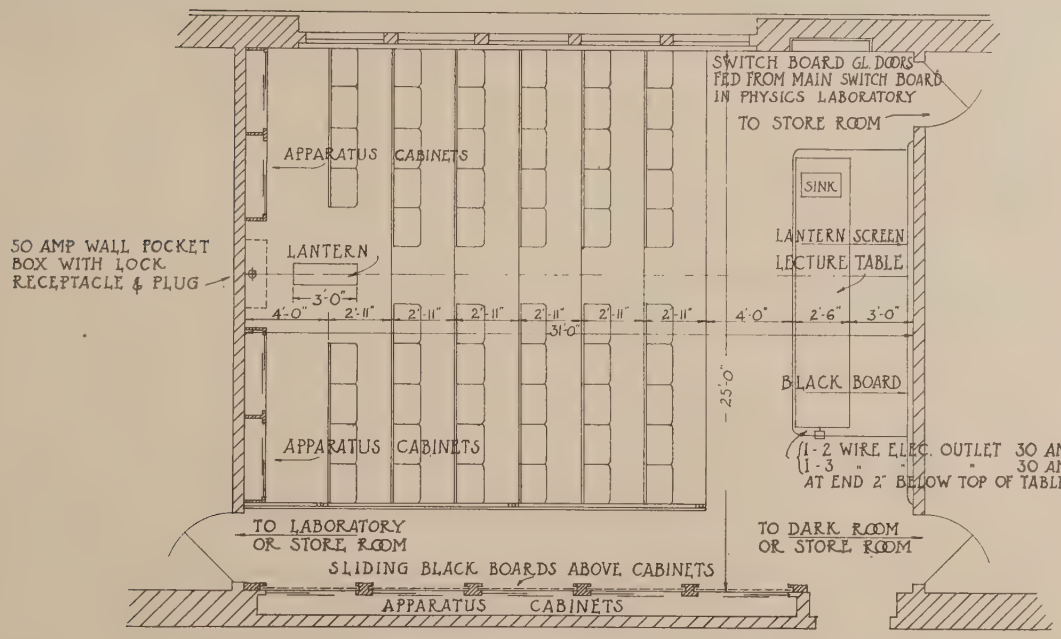
Slides. — An excellent assortment of slides for instruction in scientific lines (including portraits of famous men of science) is now for sale by such companies as the Central Scientific Co., Chicago; Knott Apparatus Co., Boston; Keystone View Co., Meadville, Pa.; C. H. Stoelting Co., Chicago. A fine series of wood sections (mounted for projection), also views of trees, bark, leaf, etc., is offered by Mr. R. B. Hough, Lowville, N. Y.

Slides can be made with the school camera as follows: 1st: If negatives can be borrowed, it is only necessary to support them in front of a uniformly illuminated white surface (or toward the sky) and photograph them on a regular lantern-slide plate. The proper size (a little smaller than the plate) must be indicated on the ground-glass of the camera, in pencil. 2d: A picture, diagram, or plate in a book can be supported in a strong light at right angles with the axis of the lens of the camera and photographed as just described, but in this case producing a negative. This, being the correct size, can be printed by direct contact (films together,



SECTION THRU LECTURE ROOM

EXTRA SKETCH


SWITCH BOARD GL DOORS FED FROM MAIN SWITCH BOARD IN PHYSICS LABORATORY
TO STORE ROOM
APPARATUS CABINETS
SINK
LANTERN SCREEN
LECTURE TABLE
50 AMP WALL POCKET BOX WITH LOCK RECEPTACLE & PLUG
LANTERN
3'-0"
4'-0" 2'-11" 2'-11" 2'-11" 2'-11" 2'-11" 2'-11" 4'-0" 2'-6" 3'-0"
31'-0"
25'-0"
BLACK BOARD
APPARATUS CABINETS
1-2 WIRE ELEC. OUTLET 30 AM
1-3 " " " 30 AM
AT END 2' BELOW TOP OF TABLE
TO LABORATORY OR STORE ROOM
TO DARK ROOM OR STORE ROOM
SLIDING BLACK BOARDS ABOVE CABINETS
APPARATUS CABINETS

PLAN OF SCIENCE LECTURE ROOM

0' 5' 10' 15'

SCALE

FIG. 305

Mr. John J. Donovan, Architect.

FIG. 306. — PHYSICS LECTURE ROOM, OAKLAND TECHNICAL HIGH SCHOOL, OAKLAND, CALIFORNIA.

black cloth backing) on another slide, thus producing a positive. The positive has its film side covered by a clean cover-glass, and a binding-strip, cut into four pieces, fastens the two together and completes the slide.

Moving Picture Films. — The assortment now (1918) within reach of educators is very limited, but certain firms have made a start and much is to be hoped for in the future.

Education films are now for rent and some of them are excellent. The teacher in charge of the matter should try to see them himself before exhibiting them. He should avoid the mawkish " historical film " (so-called) on the one hand and the uninteresting " How Canned Soup is Made " type on the other.

Used " regular " reels can be used if selected with care.

School Camera. — A kind of universal or general utility plate camera (say $5'' \times 7''$) having an extension bellows and several extra plate-holders is of very great use to the school in general as well as to the science department. It serves to preserve visual records of " great events " in the school, to photograph exhibitions of students' work, to make lantern slides, to serve as a practical illustration in Physics and to demonstrate in the study of the Chemistry of Photography.

A fairly good instrument can be obtained for from $25 to $45.

Laboratory Breakage Fund. — A science lecture course, where the instructor does the experiments, requires very little for upkeep; but all courses where students do the experimenting need constant and close supervision, prompt repairs, and frequent replacement.

The Board of Trustees can very properly be expected to provide a yearly (or twice yearly) allowance for the larger repairs, replacement, and apparatus for new courses, etc. But students must be provided at once with a new piece for a broken piece of apparatus, and a new supply at once if a certain necessary chemical, for example, is used up. Two methods for raising this fund in case the school does not pay for a student's breakage are suggested: one is to have each student

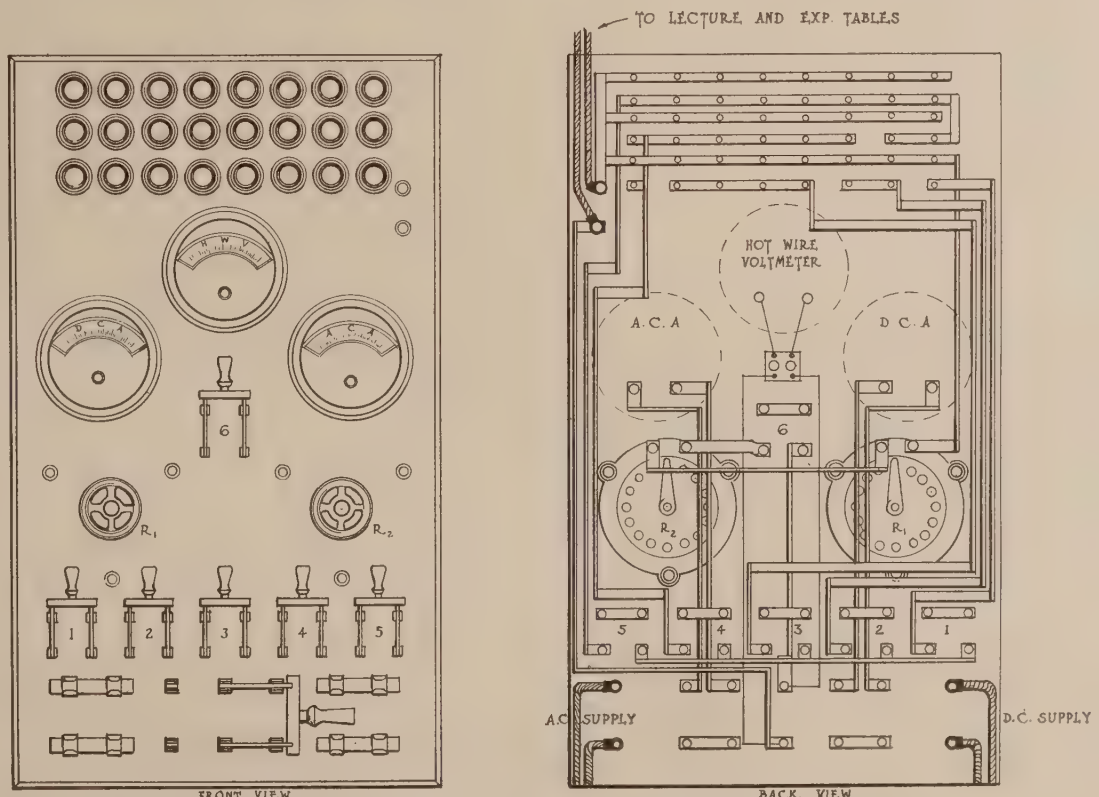
contribute a certain fixed amount on entering the course and pay his individual breakage later; the other is to have him make a larger "deposit," the balance, after the fixed amount and breakage are subtracted, being returned at the end of the course.

II. **Physics.** *The Physics Lecture Room* (See figure No. 305.) — For certain experiments in Light, sunlight is necessary. This must be available at all hours of the day because in large schools recitations occur at every period, and even in small ones, it is better to avoid interrupting the school program. Therefore the room should be on the *south side of the building* and preferably on a projecting wing. Furthermore, in many experiments in Sound a quiet room is required; therefore, in locating this room, attention should be given to this fact.

Seating. — There is no doubt that the raised bank of tablet chairs gives the student a distinct advantage in seeing the demonstrations, and it gives the instructor the same advantage in observing the student. The depth allowed for each row of chairs should be from 34″ to 38″, depending upon the length of the tablet of the chair, and the rise for each 6″ to 11″, depending upon the height of the ceiling and the length of the room. By far the best way for light to enter is from the student's left side, so the chairs should be faced accordingly; and as crosslights are unendurable, and neither class nor instructor can face the light, it follows that windows should be on one side only, which may be supplemented with skylights if necessary.

Seating Capacity. — Assuming the laboratory section to consist of from 20 to 24 pupils, and it should not exceed the latter figure, and as it is sometimes convenient (especially in large schools where program arrangements are difficult) to place two laboratory sections in one lecture section, a minimum of fifty tablet chairs should be provided. Any number between this and one hundred is therefore satisfactory, the size of the room being partly determined by the general building plan.

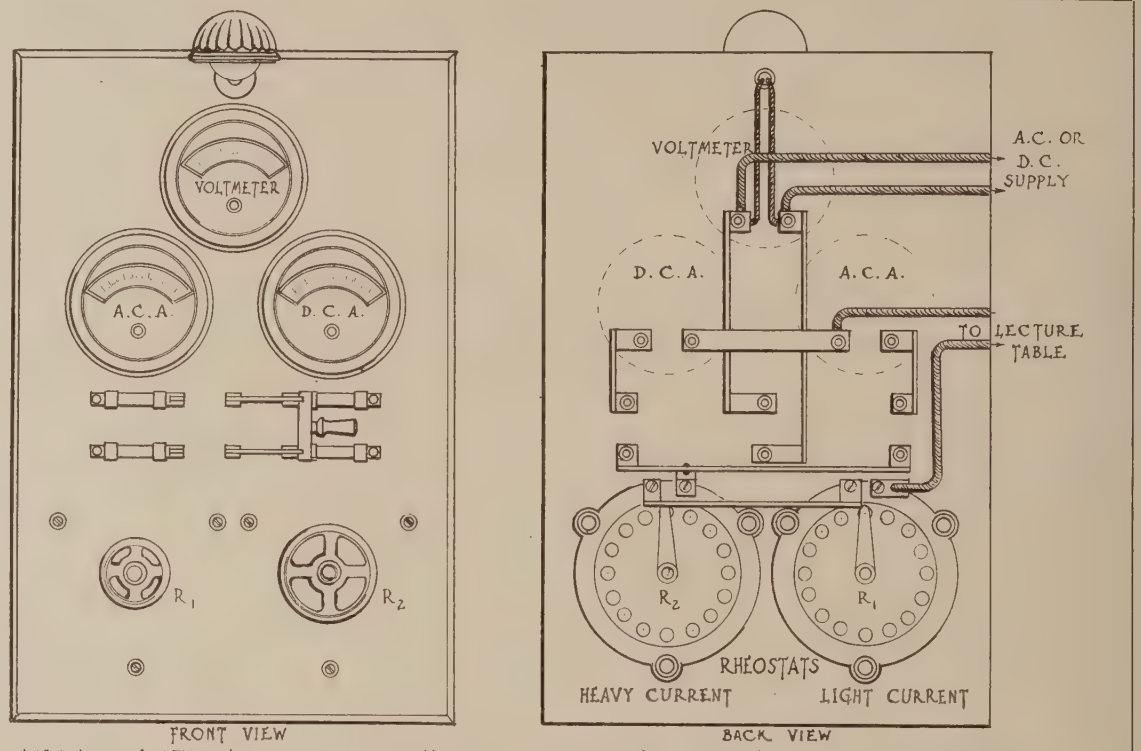
Blackboards and Chart-Posting Space. — The blackboards should be of good quality, to avoid reflection of light, and where several subjects are taught or where more than one teacher uses the room, one or two sets of vertically sliding blackboards should be



TYPICAL SWITCH BOARD FOR PHYSICS LECTURE ROOM OR FOR LABORATORY WORK IN PRACTICAL ELECTRICITY

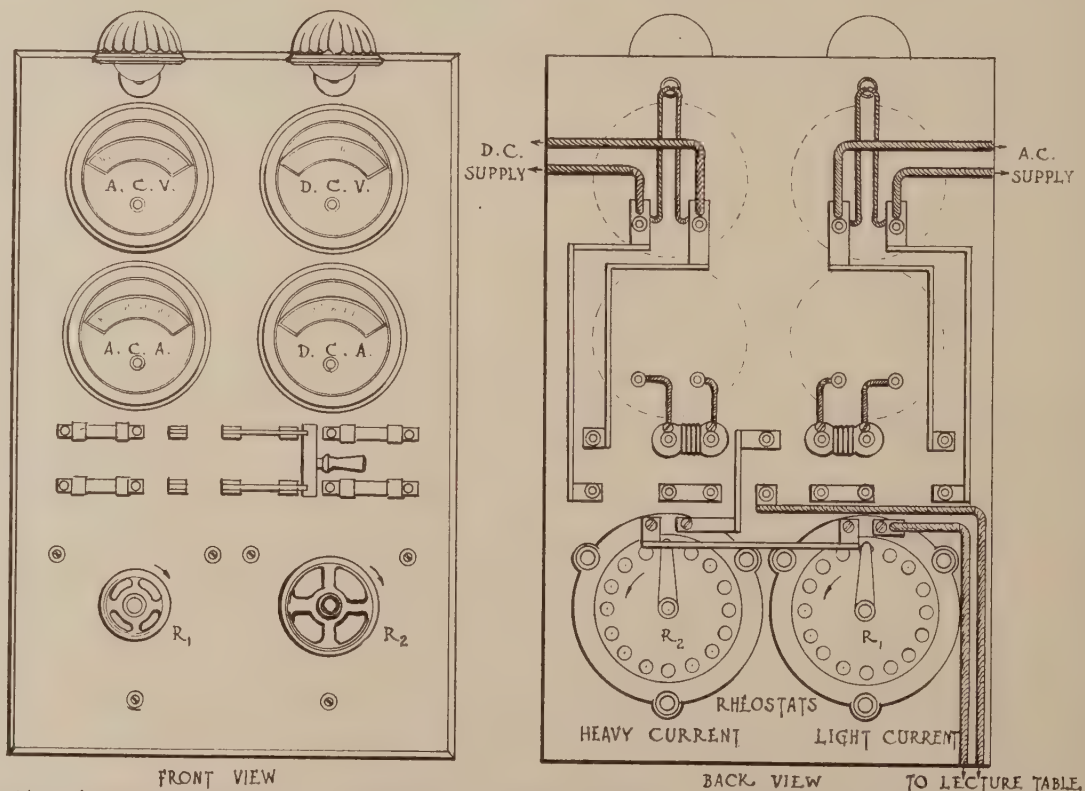
RANGE: USING LAMPS ONLY 1-24 AMP., RHEOSTATS ONLY ¼-40 AMP.

FIG. 307.



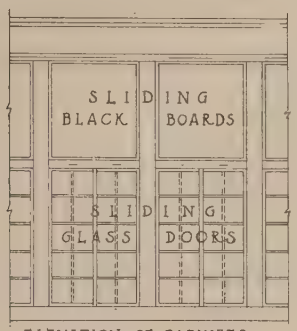
SCIENCE LECTURE ROOM SWITCH BOARD - TWO WIRE SUPPLY (NO LAMPS)

FIG. 308.

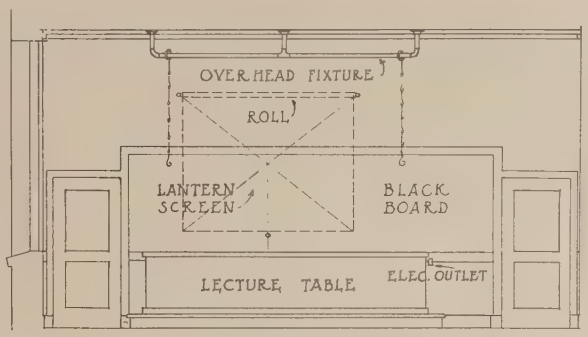


SCIENCE LECTURE ROOM OR LABORATORY SWITCH BOARD - FOUR WIRE SUPPLY (A.C. & D.C.)

FIG. 309.



ELEVATION OF CABINETS WITH SLIDING BLACKBOARDS



END ELEVATION OF SCIENCE LECTURE ROOM

FIG. 310.

installed. These should consist of two sliding pieces mounted in front of the usual board, counterweighted and fitted with small rollers at the edges to prevent the sliding pieces from binding. The fixed boards may be of slate, but the sliding pieces may better be of some material which will not weigh so much nor be subject to breakage. A chart-posting space (all the front space of the room not occupied by blackboard) should be provided by having a heavy cloth or canvas fastened to the wall, and finished in the same manner as the remainder of the room.

Lantern Screen. — The selection of the proper screen has been mentioned previously. It should be on a spring-roller and be mounted in the center of the front of the room.

Framed Pictures. — The walls may be ornamented with framed pictures of the great men of science, or of industrial applications of Physics. A bulletin board of some kind is a necessity.

Electric Circuits. — The experimental electric circuits are distinct from those for lighting and those for projection lanterns. The terminals should be at the end or back of the lecture table (not on the wall) and the strength of the currents used can best be controlled by a switchboard visible to the students, several designs for which are shown in figures 307, 308, and 309. The number of wires to be run from the source of supply depends upon the kind of service available, but should be at least *five* in number, two for direct or single-phase alternating current and three for two or three-phase service.

The subjects of furniture, plumbing, shades, and ventilation have been mentioned previously.

Overhead Fixtures for Mechanics. — For many experiments in Mechanics heavy objects and various machines (as the block and tackle) must be suspended from the ceiling. One method of providing for this is to have a number of strong hooks fastened to the floor or ceiling beams of the building and projecting a short distance from the ceiling. A better plan is to have a piece of two-inch pipe about twelve feet long fastened firmly (at three points) so as to be about one foot from the ceiling and vertically above the front of the lecture table. Two iron rings (one on each part) slipped on the pipe may have chains attached, terminating in hooks at a convenient height. See figure 310. (*Note:* This idea was published, the writer believes, in "School Science and Mathematics" a year or more ago, but he is unable to recall the name of the author.)

Special Illumination. — If the lecture room is to be used for evening school work or for other evening gatherings, two or three "scoop" reflectors, *e.g.*

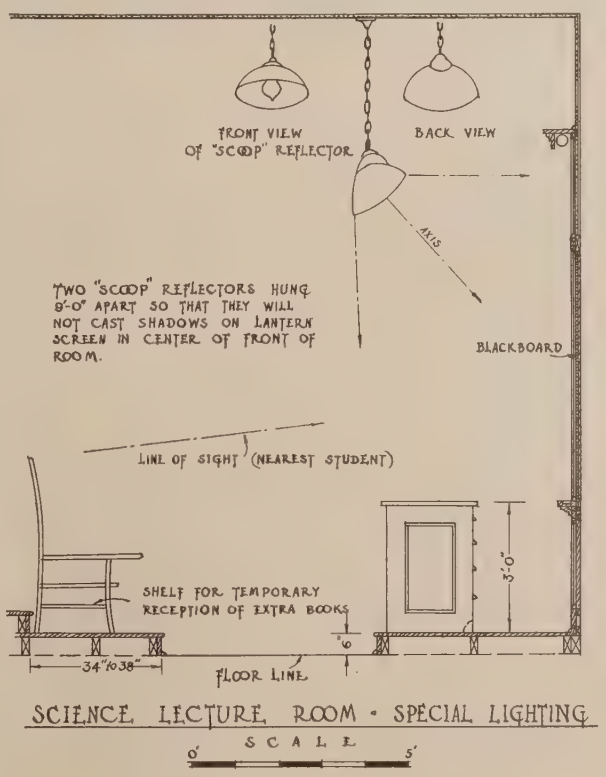
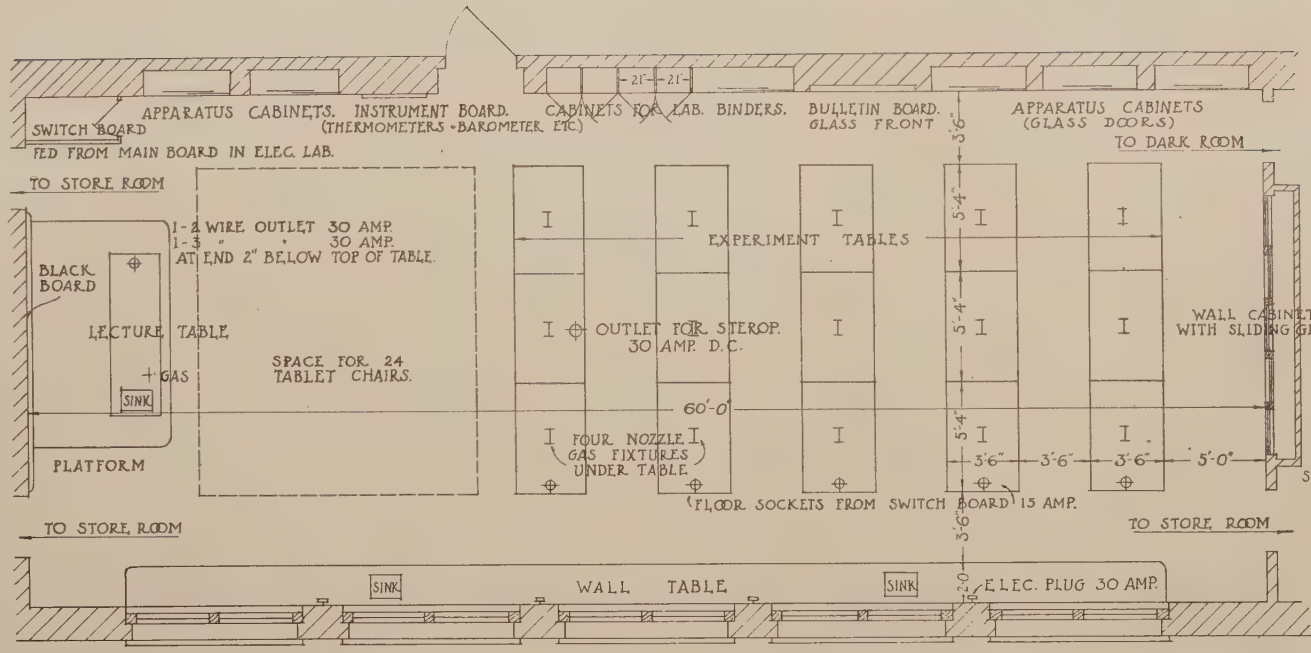


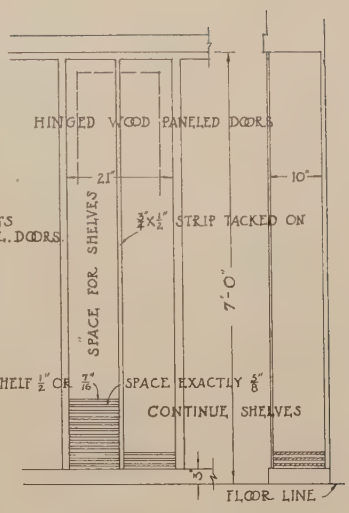
FIG. 311.



PLAN OF PHYSICS LABORATORY

SCALE 0' 5' 10' 15'

FIG. 312.

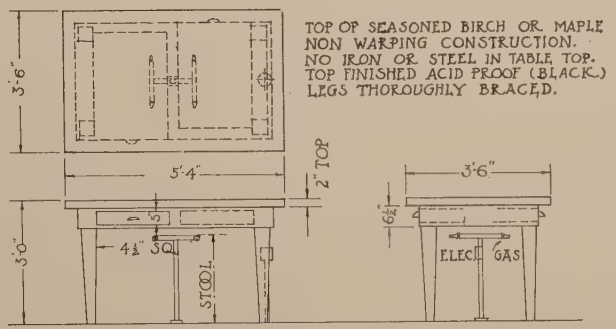


MATERIAL TO BE REDWOOD

CABINETS FOR SCIENCE BINDERS

SCALE 0' 5'

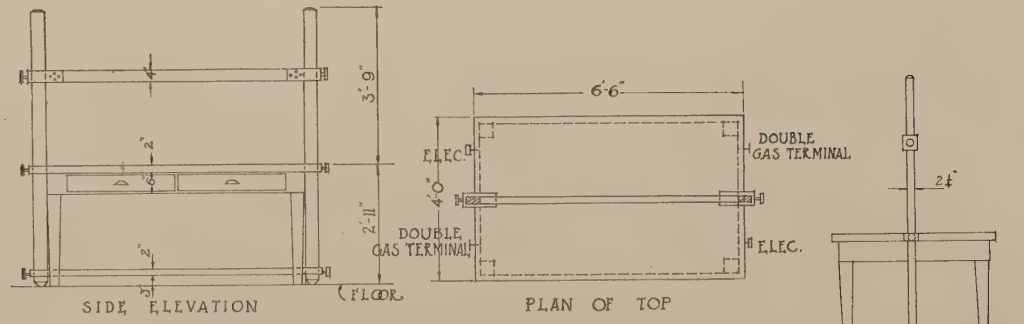
FIG. 313.



PHYSICS LABORATORY EXPERIMENT TABLE

SCALE 0' 5'

FIG. 314.



STUDENT'S TABLE PHYSICS LABORATORY
CITY OF BOSTON SCHOOL HOUSE DEPARTMENT

FIG. 315.

FIG. 316. — PHYSICS LABORATORY, GROVER CLEVELAND HIGH SCHOOL, ST. LOUIS, MISSOURI. *Mr. Wm. B. Ittner, Architect.*

Benjamin No. 5525 angle reflecting socket (see Figure 311), each holding a 200-watt gas-filled lamp, should be placed over and in front of the lecture table, in addition to the usual illuminants. These must be out of the way of the light from the projection lantern and should be on a separate circuit. In a narrow room it may be desirable to mount the lantern screen diagonally across one corner of the room to avoid having these special lights interfere with projection. The lantern, of course, would be changed to the correct location.

Some form of "trough lighting" may be used instead.

Storeroom for the Lecture Room Apparatus. — This apparatus is very bulky and yet must be kept in dust-proof cabinets. It is totally different from laboratory apparatus and must be left "set-up" so that it can be carried quickly to the lecture table. This means that a room at least 8′×10′ should be fitted up with glass-front cabinets running clear to the ceiling (movable shelves) immediately adjacent to the lecture room, except where an extra large lecture room may have the necessary space for these cabinets at the back and sides. This storeroom may have artificial light only, as it is only occupied for a few minutes at a time.

The Laboratory. — Certain experiments, as the manufacture of ice by the evaporation of ether or setting up a mercury barometer, are expensive or use expensive material, and are essentially lecture table experiments. Others, as seeing through gold-leaf or the projection of the spectrum in a dark room, while simple, can be shown to a whole class at once, and are also commonly given in the lecture room. On the other hand, certain fundamental experiments, in each of the great subdivisions of physics, must be done by the individual students in order that they may get a real foundation in the subject. Hence the necessity for laboratory work. The plan shown in Figure 312 is for a large school with overcrowded classes (35 to 40) and can be adapted to smaller rooms where such conditions do not exist. Large working space is provided because the students progress from one table to another, and new experiments must be set up ahead in proper sequence.

Good lighting is the first essential. The light should not come from two opposite sides, but can well come from one side and the end of the room.

Equipment. — The customary built-in cabinets may occupy the side away from the windows, and a wall table be built under the windows and of the same height

Mr. John J. Donovan, Architect.

FIG. 317. — PHYSICS LABORATORY, OAKLAND TECHNICAL HIGH SCHOOL, OAKLAND, CALIFORNIA.

as the other tables. A room with a wall table gives greater table space than the same-sized room without it.

A number of laboratory binder cabinets (see Figure 313) should be placed near the door (three are used in laboratory of Figure 312). These should be built in if possible.

Stools should have solid wood tops and be 26″ high. If the floor is wood the stools should be rubber-tipped; if linoleum is used, they should have metal "smooth-ons."

A very satisfactory type of table is shown in Figure 314. It has the advantage of simplicity, its top is absolutely clear, it has two drawers for the reception of the armful of books which the average student carries on his travels about the building, and is high enough to allow the stools to go underneath, thus allowing the passage-ways between tables to be cleared in an instant. These tables have a very desirable freedom of motion which is impossible where the gas pipes or electric conduits are fastened to them.

Direction Boards (Figure 318) are a necessity where the laboratory directions are typewritten, as the typed sheets are tacked up on the boards and are thus out of the way of spilled liquids, etc. The boards also furnish clean places to rest reference books. The dimensions for the double boards are correct for the laboratory tables mentioned above. Single boards are required for the wall tables and also where the laboratory tables are very wide. In the latter case, therefore, no double boards need be ordered.

The gas pipes and the electric conduits should be laid under the floor, the gas nozzles being placed just below the body of the table, the electric terminals about 2 feet from the floor line. The tables are thus not only movable, but no iron occurs on the surface of the table, a condition favorable to certain experiments in magnetism and electricity.

A useful type of laboratory switch-board or lamp-board, whose wires run to the sockets mentioned above, is shown in Figure 321. This is "fool-proof" and allows several sets of students to work at one time. When the lamps are lit the instructor is informed as to what is going on. Also, no argument should be necessary as

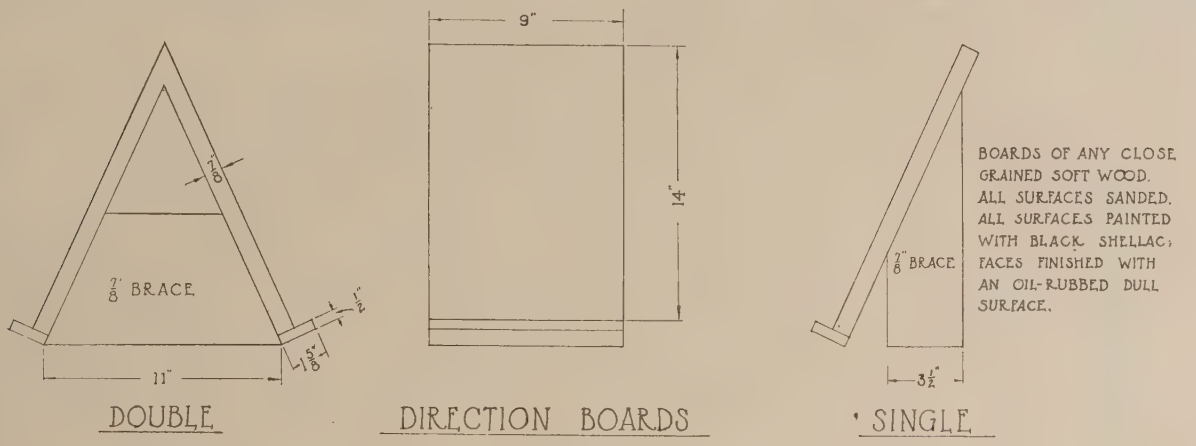


FIG. 318.

to the immense superiority of dynamo current to that from most troublesome batteries.

By leaving a little space at one end of the laboratory, which should be extra large on this account, and having a lecture table and a few tablet chairs there, the laboratory can be used as a lecture room. This overcomes the frequent difficulty of having the lecture room in demand by the principal or a teacher, when it is programmed for the physics class. This provides temporary recitation space when the lecture room is already occupied, and the teacher of the laboratory section wishes to change the laboratory period to a recitation period. Two or more storerooms should be adjacent to the laboratory. These can be fitted up as dark rooms, as described later.

Cabinet and Drawer Locks. — So much of the apparatus is valuable (opera-glass, telescope, camera, pocket barometers, pocket compasses) and so many small tools (steel rules, micrometers, pliers, wrenches) are easily stolen, it is desirable to be able to lock most of the cabinets and drawers. To save the instructor endless delay and carrying an enormous bunch of keys, a set of good locks with a single key should be ordered ahead of time from a reliable lock-making firm.

Wall Cabinets. — Two types of wall cabinets are shown in Figure 319. These are of two shapes, to fit into narrow or wide wall spaces, and should be fitted with the locks just mentioned. They are useful in all of the science rooms.

Storerooms. — The physics laboratory table previously referred to is sometimes made into a massive affair with large numbers of drawers built down to the floor. This not only leaves the room cluttered with stools, but also gives extra work to the janitor and makes it difficult to find apparatus stowed away in the drawers. The laboratory itself should be lined with glass-front cabinets where some of the apparatus can be kept. For the larger portion an excellent plan is to have two more rooms (lined with shelves) which may have artificial light only, which provide a place for classifying apparatus so that it may be kept in order and found at short notice when required. These rooms, if provided with means for ventilation, can also be used for dark rooms, as mentioned in the next section.

Dark Rooms for "Light" and for Photography. — A number of important experiments in "light" (photometer, spectroscope, focal length of lenses) require a dark room 8′×12′. Two rooms at least are needed so that two sets of students can work without mutual interference. Storerooms can be used by the installing of a wall table, covering the entire interior of the rooms with a good quality of non-glare paint (cement mixed

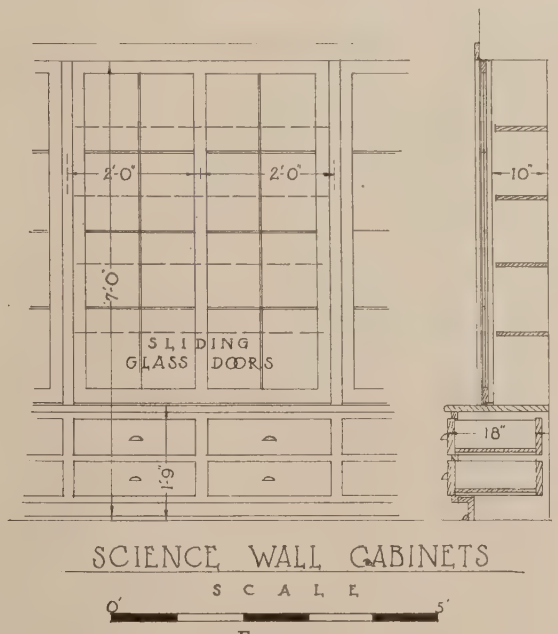


FIG. 319.

with ordinary black paint will do) and providing the necessary forced ventilation. This should be planned by the ventilating engineer. A small airtight room soon becomes uninhabitable when occupied by two or more students with a gas jet or two. A room used for photography should be scientifically ventilated, and the need for complete exclusion of daylight is greater still. Even if a dark room has been planned for the work in chemistry, another should be set aside for physics. A very good feature, if space is available, is

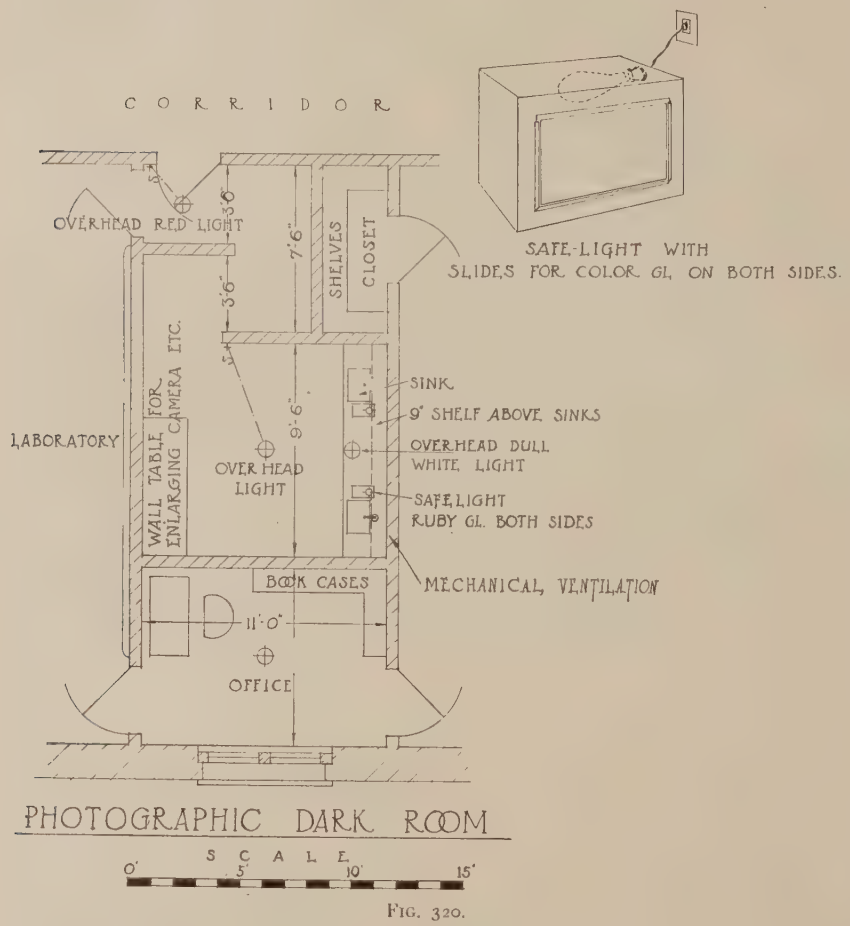


Fig. 320.

to have a U-shaped entrance so that entrance may be made without opening a door. (See Figure 320.)

The gas nozzles for spectroscopic and other experiments as well as special electric circuits for experiments with vacuum tubes, etc., should be provided in these rooms in addition to the circuits for lighting.

III. Applied Physics. *Special Laboratories.* — Just as in agricultural communities the people are demanding that their children be instructed in agriculture, and in places where mining is the leading industry the high school cannot afford to neglect assaying and mineralogy, so *in most cities* the public are usefully served if the pupils are given work which will benefit not only the minority who go to college, but also the majority who do not.

A growing demand, which would be overwhelming if our communities took the direct interest in their children's welfare to which its importance entitles it, makes it desirable to establish courses which may be labeled as follows: *mechanics, strength of materials, steam and gas engines, hydraulics, direct and alternating current electricity.*

It is not pretended that these courses will turn out the equivalent of that turned out by the corresponding university course; but the plumber's helper, or the beginner in an automobile repair shop, will rise more quickly if he has had a course in elementary physics, followed by one in the lines mentioned. The contractor, the builder of stone or brick or concrete houses, the men in the foundries, the machine shop, the factory, the automobile business, the telephone and telegraph companies, the electrical and wireless industries, the boiler and engine rooms, all need a foundation of this kind. These courses correlate well with the continuation and part-time schools being organized in a few parts of the country. They are especially well adapted to evening schools also. Lecture courses (with experimental demonstrations) along these lines have been given with marked success in some places, as part of the university extension movement. The first thing is to get the necessary money to equip laboratories for the courses spoken of.

The public, the school administrators, the boards of education, the superintendents, the principals (many of whom, unfortunately, from the very nature of their training as administrators have never done laboratory work themselves) must then be educated to the fact that such work is expensive. Classes must be small (18 to 24 students only), rooms fitted with heavy apparatus and machines cannot be used for other purposes, and the apparatus is very costly. For example, a small (3 horse power) gas engine, flywheel generator belted to it, with other attachments cost (in 1915) $262.00; the cheapest universal testing machine made by one of the best known companies, 10,000 pounds capacity, cost (same date) $300.00; a motor-driven 3 horse power centrifugal pump cost $227.00; and so forth.

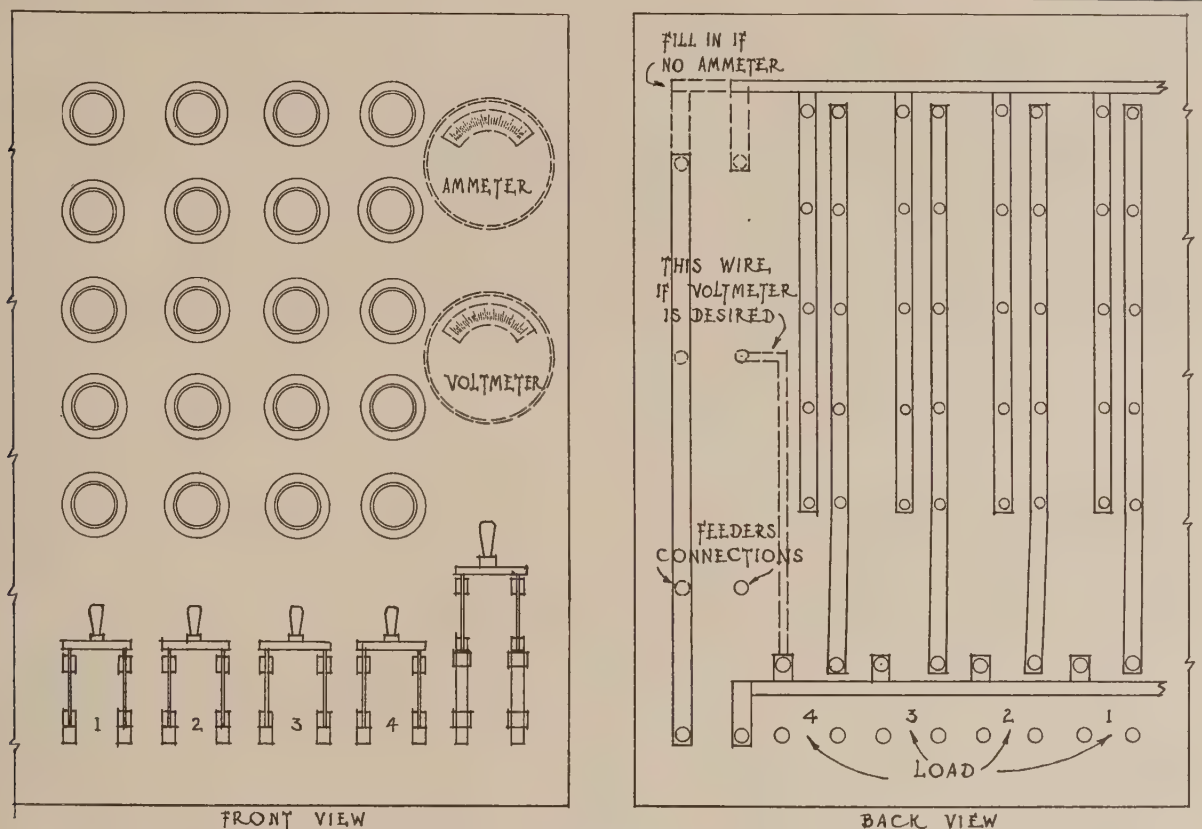


FIG. 321.

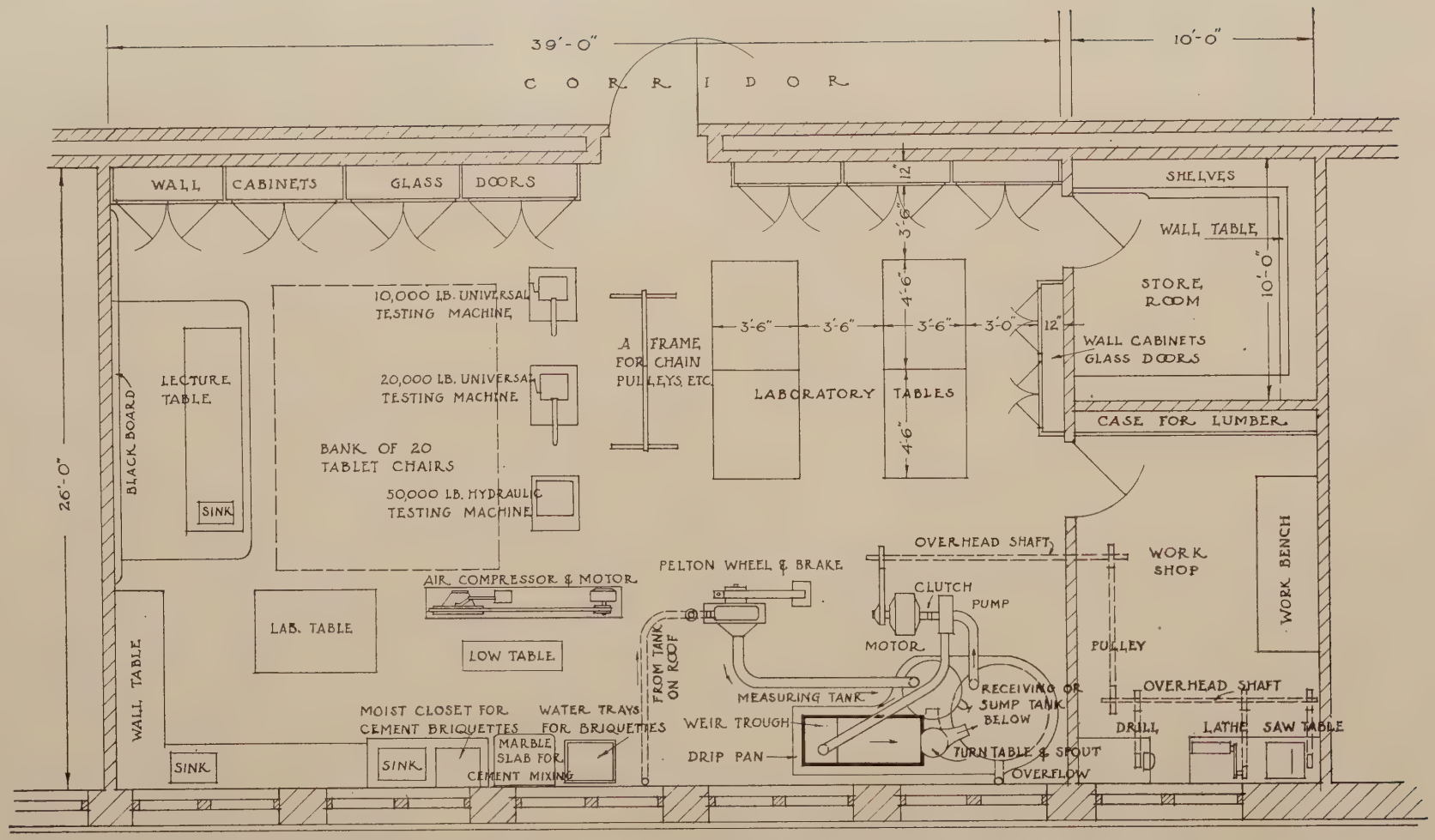
It is to be kept in mind that the following laboratories are to be in addition to the physics laboratory, and, as mentioned before, the corresponding courses are to follow a fundamental course in physics. This is to be done by giving the second year of high school to physics and the following two years to some of the special subjects.

Similar courses in mechanical drawing, machine shop, etc., are desirable; and the customary courses in mathematics (algebra and plane geometry) should be insisted upon. Much of the work in the applied physics courses can be done with the aid of arithmetic alone, but algebra, plane geometry, and sometimes trigonometry are also necessary.

Laboratory for Mechanics, Strength of Materials and Hydraulics. — A well-lighted room, with a floor specially designed to hold great weight, is necessary for the first two subjects. (See Figure 322.) For mechanics, one essential is some form of A-frame, wood or metal, nearly the height of the room, to be used for the suspension of pulleys, differential and duplex chain-hoists, etc. The floor beams above may be designed for this purpose. Some cubes of concrete (150 to 300 pounds), each provided with a strong hook, should also be obtained.

Several small universal testing machines, hand driven, are far better than one high-power machine (same total cost) because, obviously, only two or three of the class can be kept busy if there is only one machine, the remainder of the students being spectators. The size of the room depends upon the amount of equipment to be installed.

Experiments in Hydraulics. — For hydraulics, provision must be made for the inevitable splashing of water. One way is to have the driving machinery (as motor and pump) inside the room and the measuring devices (weirs) in a protected or inclosed space outside where conditions permit. Experiments with high-head and low-head centrifugal pumping, the use of the weir, the hook gauge, the reciprocating pump, the Pelton type of water wheel, and the hydraulic ram are desirable, and the closely related subject of compressed air can be studied by experimentation with small fans, centrifugal blowers, and a compressor set. Three or four tanks are required for the hydraulic experiments: one on the roof to supply the impulse wheel (a standpipe may be employed if the building is low), one or two for measuring the discharge of the pumps, and one large tank set lower than the pump-level for the general discharge and suction pipes. The impulse wheel should also be connected to the



MECHANICS, STRENGTH OF MATERIALS AND HYDRAULICS, ALSO SHOP

SCALE

0' 5' 10' 15'

FIG. 322.

FIG. 323. — ELEMENTARY MECHANICS LABORATORY, PRATT INSTITUTE, BROOKLYN, NEW YORK.

water supply of the building. Platform scales and a portable tank are also necessary.

A few tablet chairs and a blackboard at one end of the laboratory give the lecture room facilities required. A lecture table is desirable.

Steam and Gas Engine Laboratory. — This room also may require extra support for the floor on account of the weight of the machines in it. (See Figure 325.)

A few experiments, as those on the measurement of heat and the properties of steam, can be done with simple apparatus; but the study of steam and gas engines must be made with the engines themselves. If the school has a steam or gas engine as part of the general plant, observations at least can be made on it. (Sometimes the students can help in actual tests, as in taking indicator diagrams; sometimes they can be used in regular shifts.) If not, visits can be made to power stations using large engines or turbines. Indicator cards may be taken from an air-compressor set if it is not too small.

The detailed study, however, should be made *in the laboratory*, as follows: first, small models of engines (sectional) can be purchased from the apparatus dealers; second, models for the study of crank and cross-head motion, eccentrics, types of valves, valve-motion, lap and lead, angular advance, etc., can be constructed of wood or metal by the students (see Ripper, "Heat Engines," Perry, "The Steam Engine," etc.); third, old parts of steam and gas engines can be bought cheaply from second-hand dealers, particularly junk men. Frequently machines which have passed through a fire can be cleaned up and used for study.

A few small engines which will really operate are very desirable. Steam engines can be run for demonstration purposes by compressed air. Many gasoline engines can be adapted to the school gas-supply by simply removing the carburetor and putting a small gas bag (of heavy rubber) in the supply line. The gasoline, for engines using it, must be handled in small quantities and with great care. The engines can be tested by attaching them to a Prony brake, dynamo, pump, or some form of dynamometer.

FIG. 324. — ELEMENTARY MECHANICS LABORATORY, PRATT INSTITUTE, BROOKLYN, NEW YORK.

The piping for compressed air, gas, and steam, also for exhaust and steam, should be planned beforehand by the instructor, in consultation with the engineer of the architect's staff.

The size of this laboratory, like that of the previous one, depends upon the amount of machinery to be installed.

Laboratory for Direct and Alternating Current Electricity. — The work in direct currents must precede that in alternating currents because the former is a foundation for the latter. For the same reason both are preceded by some work in the beginnings of electricity taken in Elementary Physics.

The Machines. — Many of the machines and pieces of apparatus for alternating currents are different from those for direct currents, so a separate room is sometimes desirable; but as classes in these subjects (third and fourth years) are usually not numerous, one large room will suffice (1300 to 1800 square feet suggested). (See Figure 328.) The floor must be well supported in this room also. The three important things for the room are the machines, the measuring instruments, and the switchboard with its distributing wires.

Representative machines (particularly motors and generators) must be provided. That is, while most of them may be small ($\frac{1}{2}$ to 2 horse power) they must represent the important kinds of direct current, also single and polyphase alternating current machines in use to-day.

One large machine (say 10 horse power) must, of course, be in commission all the time, so that, in conjunction with the street service, the main switchboard is supplied with direct, single-phase alternating and polyphase alternating currents. Of the small machines, the dynamos must have means of driving them and the motors are to be provided with some easily controlled load (generator, fan, blower, friction brake, rheostats, etc.). Consultation with representatives of two or three of the largest electric manufacturing companies is recommended before purchasing machines. Good types for instruction purposes may often be obtained from dealers in second-hand machinery.

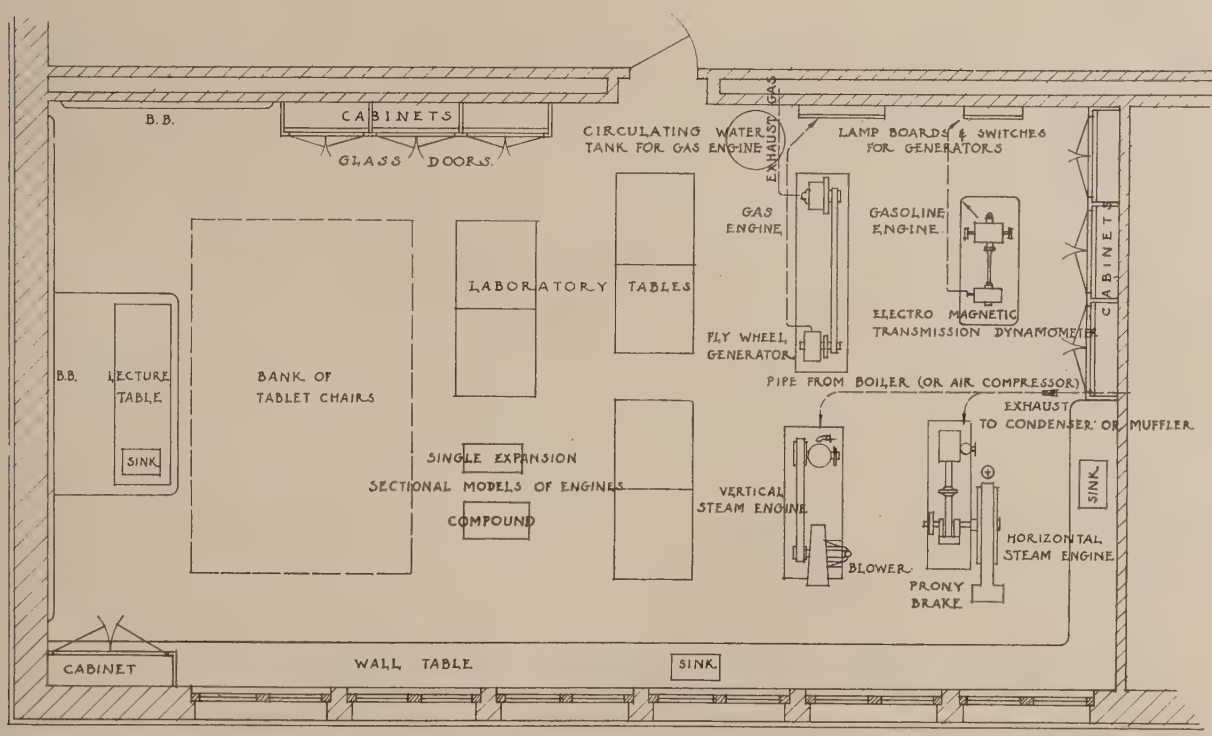
The location of the machines should be planned carefully. The best method of fastening them is to bolt them down to a solid concrete base one foot or more above the floor. Heavy wood benches are good, as they allow bolts to be shifted easily, but ordinary tables are not heavy enough and are noisy, for they act as sounding boards.

Measuring Instruments. — Measuring instruments include voltmeters, ammeters, wattmeters, and some others, as curve-drawing instruments, galvanometers, etc. They should be of the best quality (Weston or equivalent) and are expensive, but a fairly large supply is necessary. They must be handled very carefully, and a method of checking them out to students should be devised. In some cases a separate storeroom can have a counter over which the instruments can be checked out and in again by one of the reliable students or by an assistant.

Switchboards. — A main switchboard, with the necessary meters and switches associated with the corresponding panels for distributing the various kinds of current to the places where it is to be used, is the first consideration. (For a suggestion, see Figure 330.) It should not be in a separate room, but should be in plain view of the instructor at all times. It is an extremely good plan to have the current for all the rooms of the Science Group, as well as that for the auditorium (for experimental demonstrations), and that for the projection lanterns, controlled from this board. The board should be of standard power-plant type and its rear should be accessible to the students. Extra money spent on good construction is regained in durability; but "fancy fittings" should be avoided — the writer was once allowed to view a high school switchboard made of very heavy plate glass!

In addition to the experimental switchboards in the various rooms of the Science Group, one or two boards are needed for the electrical laboratory. (For example, see Figure 309.) There must be a large number of circuits (say 18) for student use. These are to be preferably overhead, so that they can be supervised by the instructor. Each one of them should be on its own switch so that one group of students will not interfere with another group.

The voltmeters, ammeters, wattmeters, power-factor indicator, and curve-drawing instruments of the main board may have a possible addition in the shape of a glass-inclosed watt-hour meter connected to one of the supply lines. If a frequency-indicator is desired, it should be portable, so that it can be used in various parts of the room.



STEAM AND GAS ENGINE LABORATORY

SCALE
0' 5' 10' 15'

FIG. 325.

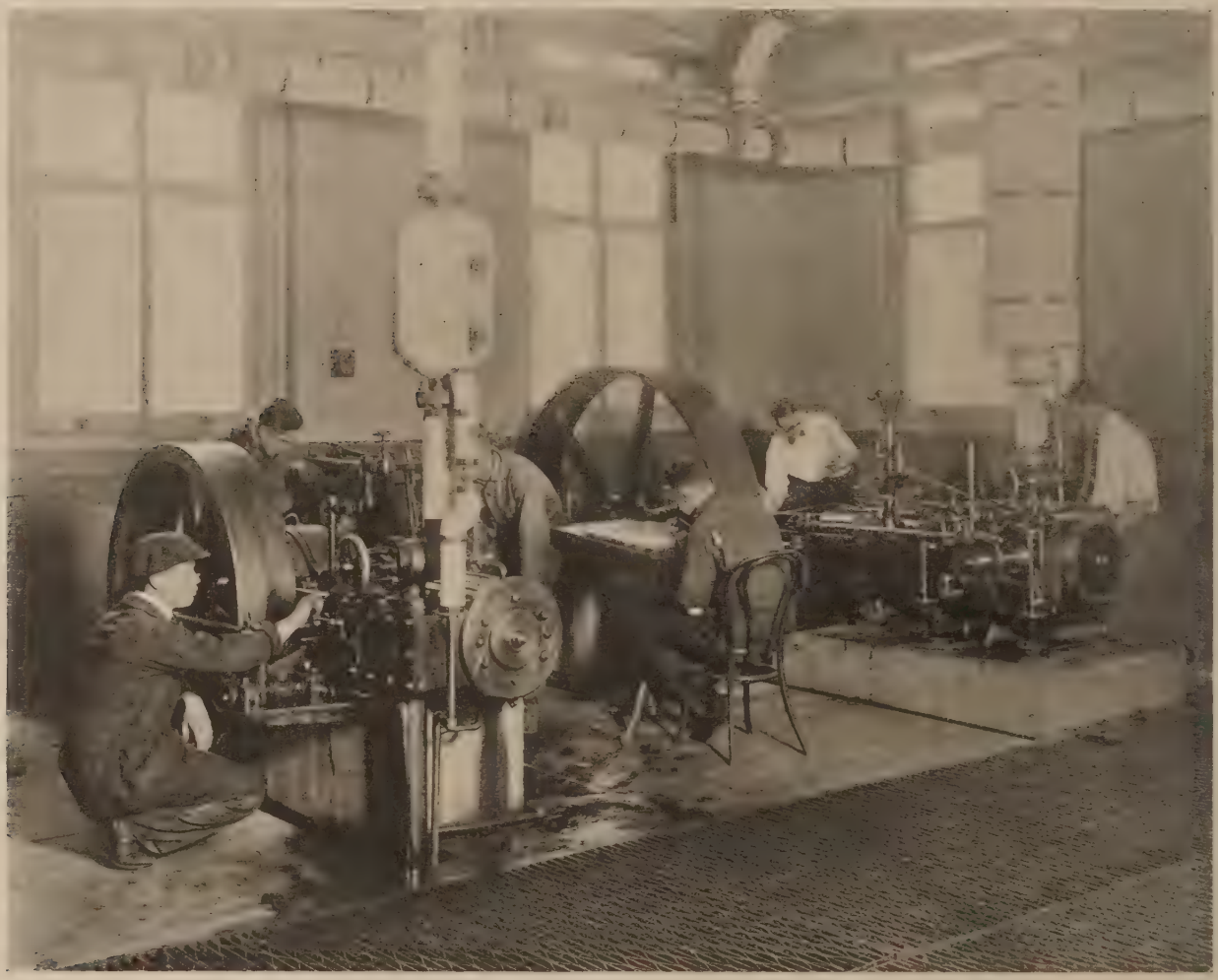


Fig. 326. — Corner of Steam Engine Laboratory, Pratt Institute, Brooklyn, New York.

Lampbank. — The discussion of switchboards would not be complete without mention of a most useful type of "portable switchboard" called for convenience a lamp-bank. (See Figure 331.) A large number of these can be built at the school, the necessary expense being for the lamp-sockets, double-pole, double-throw switch, lamps, fuse-block, a small amount of wire and lamp-cord. The old style carbon 32-candle-power lamps are good ones to use, but special resistance lamps for watt-hour meter loads may also be purchased. The lamp-banks should be built of various capacities. A suggested list follows: Four 1-lamp, four 2-lamp, two each of 4-lamp, 8-lamp, 16-lamp, making 14 boards. They are superior to all other resistance boards or rheostats because of the ease of supervision; and by providing an experiment with the proper lamp-bank the instructor may rest secure in the knowledge that the other apparatus furnished will not be ruined because of excessive current.

Apparatus. — The key-note for the selection of laboratory experiments and the necessary apparatus for this performance should be "*What is used in practice?*" An experiment on an electric disk stove, flat iron, or immersion heater is of more use than one on melting german-silver wire; volt-meters are more used in practical work than galvanometers; determining the watts per candle power of a certain kind of tungsten or "Mazda" lamp is of value to every user of lamps; a study of telephone practice must be made with real telephone equipment, and so on. This apparatus, as well as the machinery, instruments, and switchboards mentioned above, is costly; but if it is properly taken care of it will last indefinitely and be of use to class after class of students.

Many manufacturers, instrument repair firms, and others are glad to donate parts of their machines or goods, which when mounted and labeled properly, *make valuable display and lecture table material.*

Storerooms. — All three of the laboratories just mentioned should be provided with commodious store-rooms.

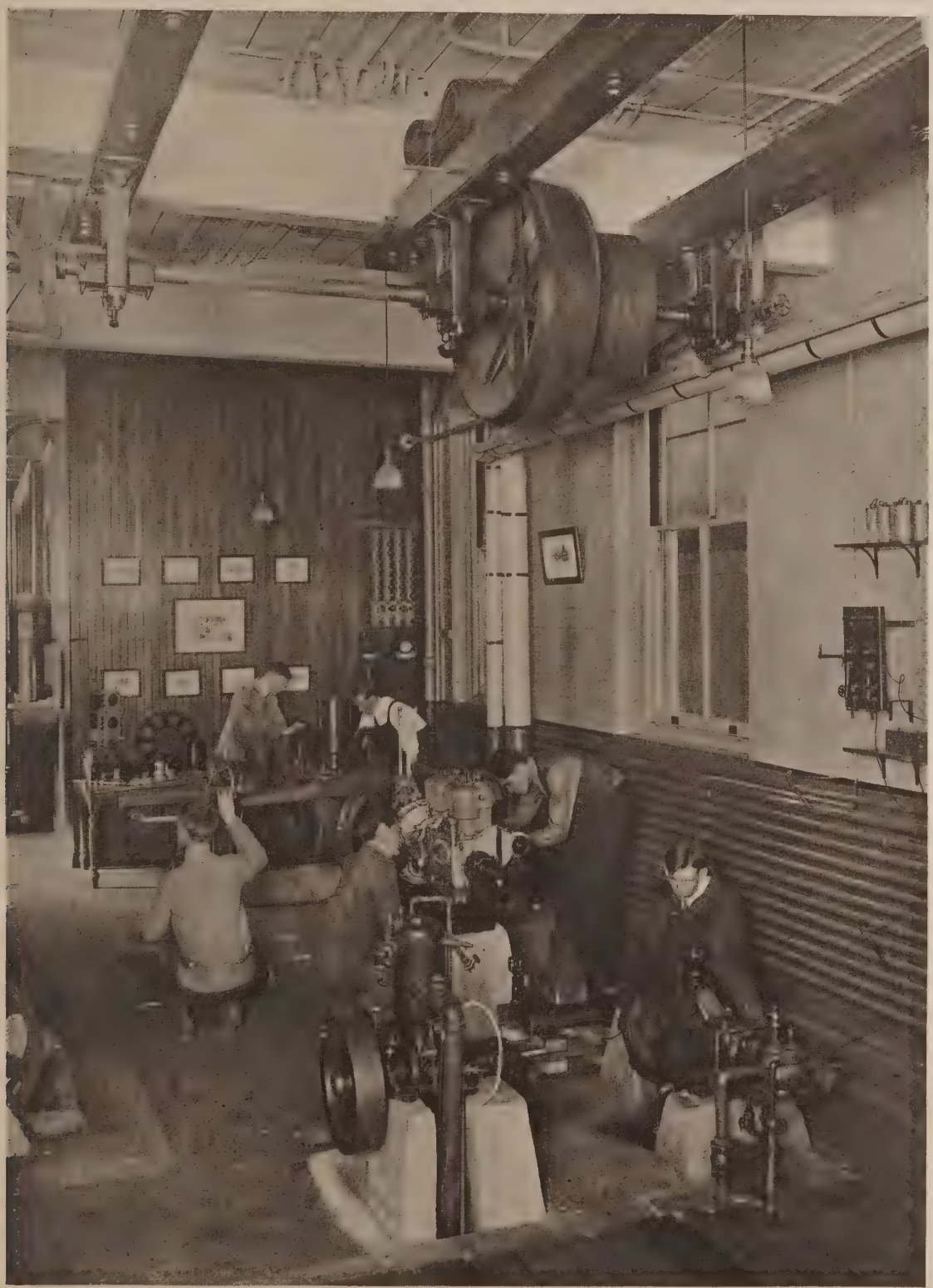


FIG. 327. — TESTING INTERNAL COMBUSTION ENGINES, PRATT INSTITUTE, BROOKLYN, NEW YORK.

Lecture Rooms. — For courses in Applied Physics a well equipped lecture room is desirable; but the theoretical and recitation work can be given in any classroom having a blackboard, and the instructor's demonstration experiments may be given in the laboratory.

All of the foregoing shows the need of designing the rooms of the department so as to house the equipment properly.

IV. Chemistry. *The Lecture Room.* — The general features of a good science lecture room have been discussed in Part II (Physics), and the statements made concerning the location of the room, raised bank of chairs, seating capacity, blackboards, lantern screen, framed pictures, experimental electric circuits, and special illumination apply with only slight modifications to a room used for chemical lecture experiments. The additional necessities are a means for forced ventilation, a fume closet, a large gas-supply nozzle, and possibly a deeper sink.

The lecture tables shown in figures 301 and 302 are suitable, where the wide drawers can be used to hold charts, long glass tubing, etc. One very desirable addition (which may be incorporated in the design of the table) is a sheet of wire plate glass about 2 feet high by 3 feet wide, mounted vertically in the middle of the front edge of the table, so as to protect the nearest students in case of accidental spattering of acid, burning chemical, etc. This should be fitted with a hoisting and lowering device, or be on a stand so as to be movable.

A number of refinements may be added. A hoisting device for a large glass pneumatic trough, worked by a crank, is very convenient. So is a method of darkening the room by having all of the dark shades lowered simultaneously. This is done in some German lecture rooms by a crank and gears on a long shaft; in some American colleges they are lowered or raised by a geared electric motor attached to wire cables.

Storerooms for Lecture Table Apparatus. — One or more rooms (located near the lecture room) should be fitted up with movable shelves covering the entire sides of the rooms. Two hundred square feet of floor space will probably be sufficient.

The Chemistry Laboratory. — Figure 332 gives a laboratory plan which allows for thirty students as a maximum. Here the students do not progress from one table to another, but each has his own place. Another thing which distinguishes the room from the Physics laboratory is the fact that wider aisles are required on account of the possibility of one student spilling acids on another (if room is crowded) in carrying them to his table. The plan provides for tablet chairs and a lecture table, thus making the room (where there are not two or

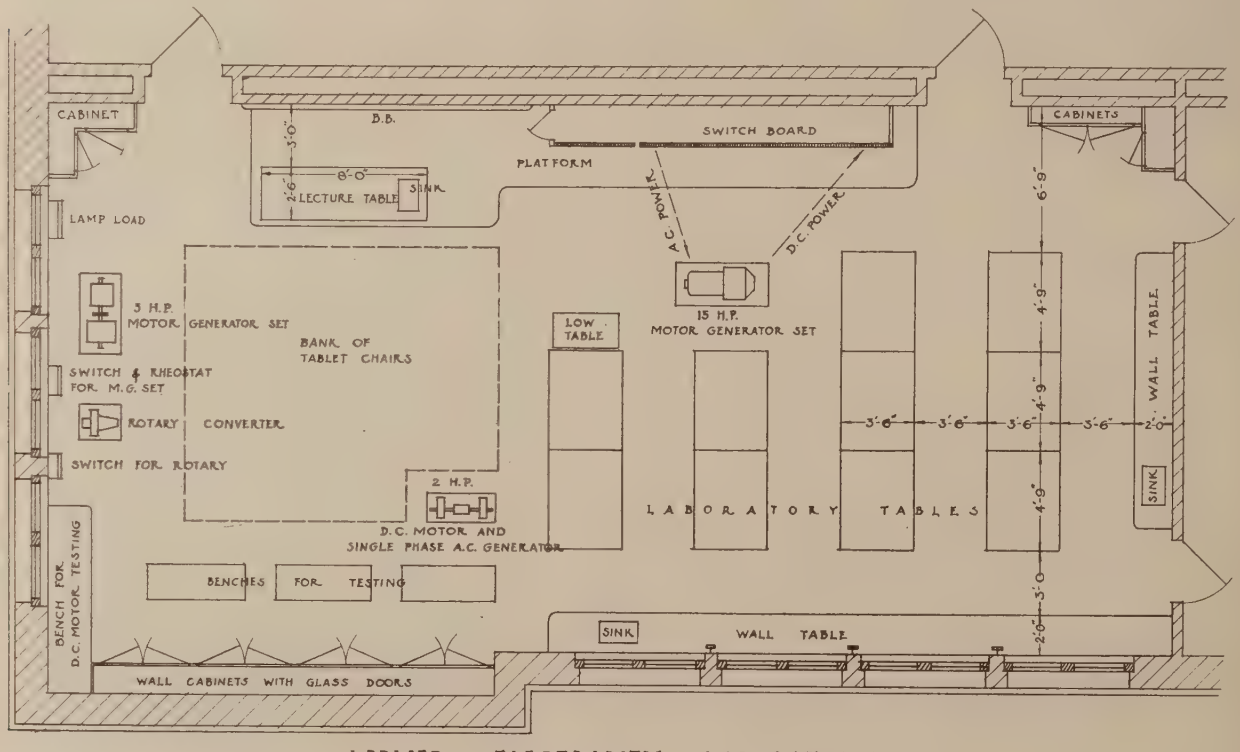


FIG. 328.

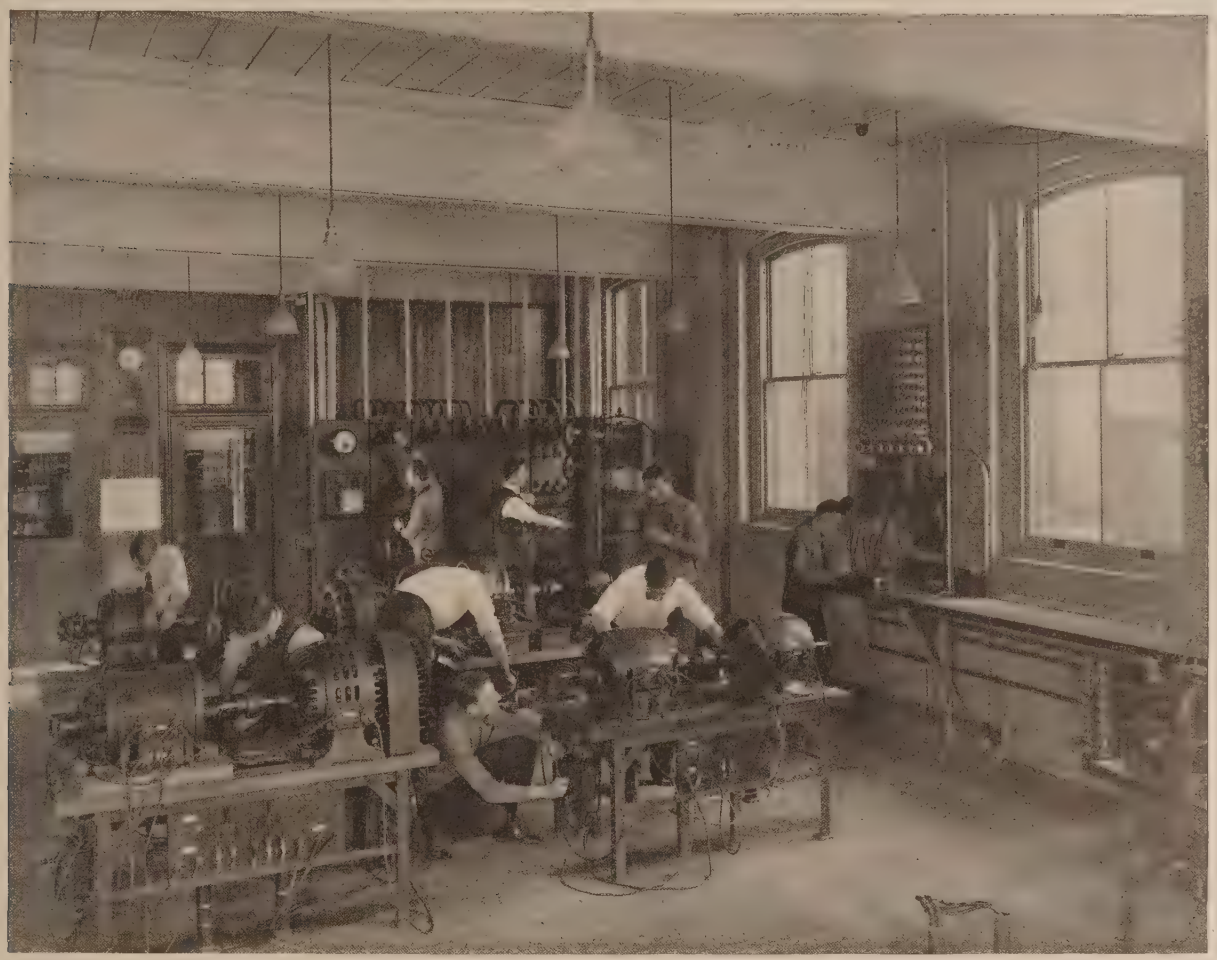


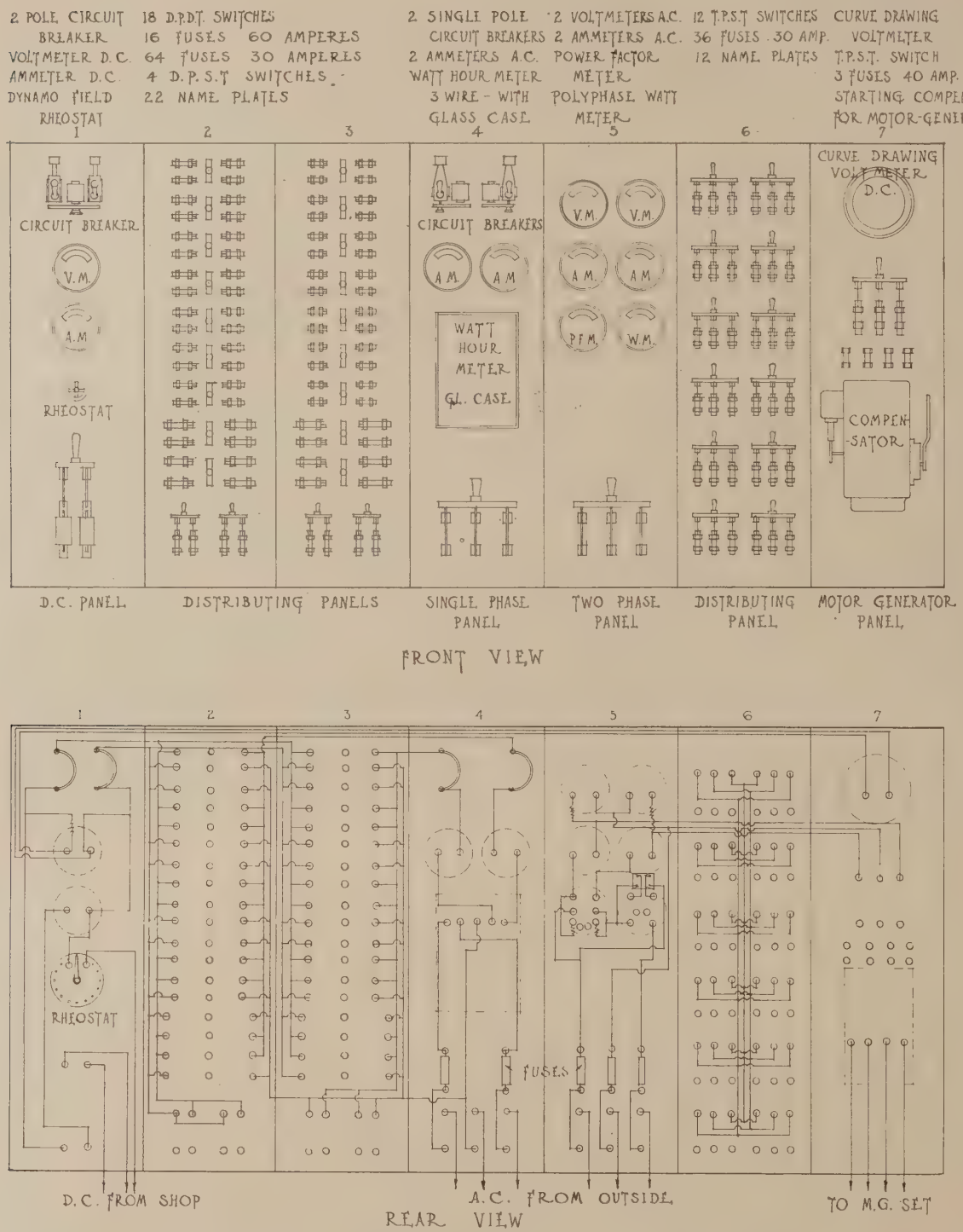
FIG. 329. — CORNER OF ELECTRICAL LABORATORY, PRATT INSTITUTE, BROOKLYN, NEW YORK.

more classes at any one period) independent of the lecture room. In crowded schools, by having two teachers, one class may be reciting in a separate room while the other is in the laboratory; but in very large schools two or more laboratories are necessary.

The fume-hood should be large (at least 8 feet long), well lighted preferably by daylight or if not by a powerful vapor-proof electric light, and ventilated mechanically. A large opening near the ceiling of the laboratory (having a separate fan) provides adequate exhaust ventilation for the room at the times required. The motors for both these exhaust fans should have switches (with keys in the hands of instructor) so that they may be turned on when injurious or offensive gases are being studied, and turned off to save current when not needed.

The previous discussion under Physics of lighting, stools, and storerooms applies also to Chemistry. Linoleum has been found to be a good material for floors. The wall cabinets marked " reagent cases " differ from those used in Physics because of their shallowness. They allow for one row of bottles only. The shelves should be movable, and most of the cabinets should have glass doors. Sliding doors, if well fitted, are more convenient in a crowded room than those which swing out on hinges. Grease-traps (useful for catching matches, broken bits of glass, etc.) may be under each table or one large one may be used for the entire room. An alternative scheme is to use hoppers at the end of each table. Cases for laboratory binders may be separate or " built in " as shown. The wall-table provides a place for many special experiments, especially for those on electrolysis.

Switchboard. — A design for a switchboard is shown in Figure 335. This provides for four sets of terminals. Any apparatus connected to " C " or " D " is in series with the lamps, and wires attached to binding-posts p^1 and p^2 may be touched without together causing damage. S_1 and S_2 represent small snap switches, these and the binding-posts to be mounted about one foot above the wall table. Five sets of these, in parallel, allow ten students to work at one time without interfering with each other. " A " and " B " are connected



MAIN SWITCH BOARD FOR SCIENCE DEPARTMENT FOR A LARGE COSMOPOLITAN HIGH SCHOOL

SCALE

0' 3'

FIG. 330.

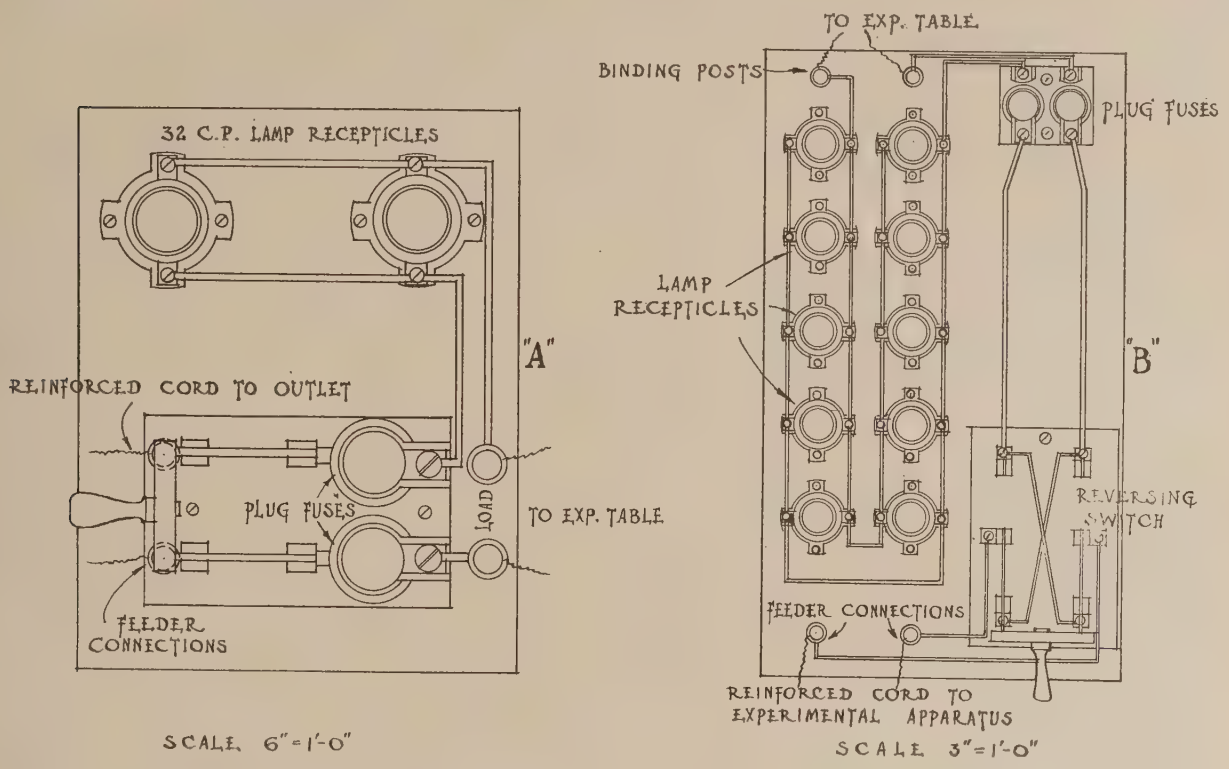


FIG. 331.

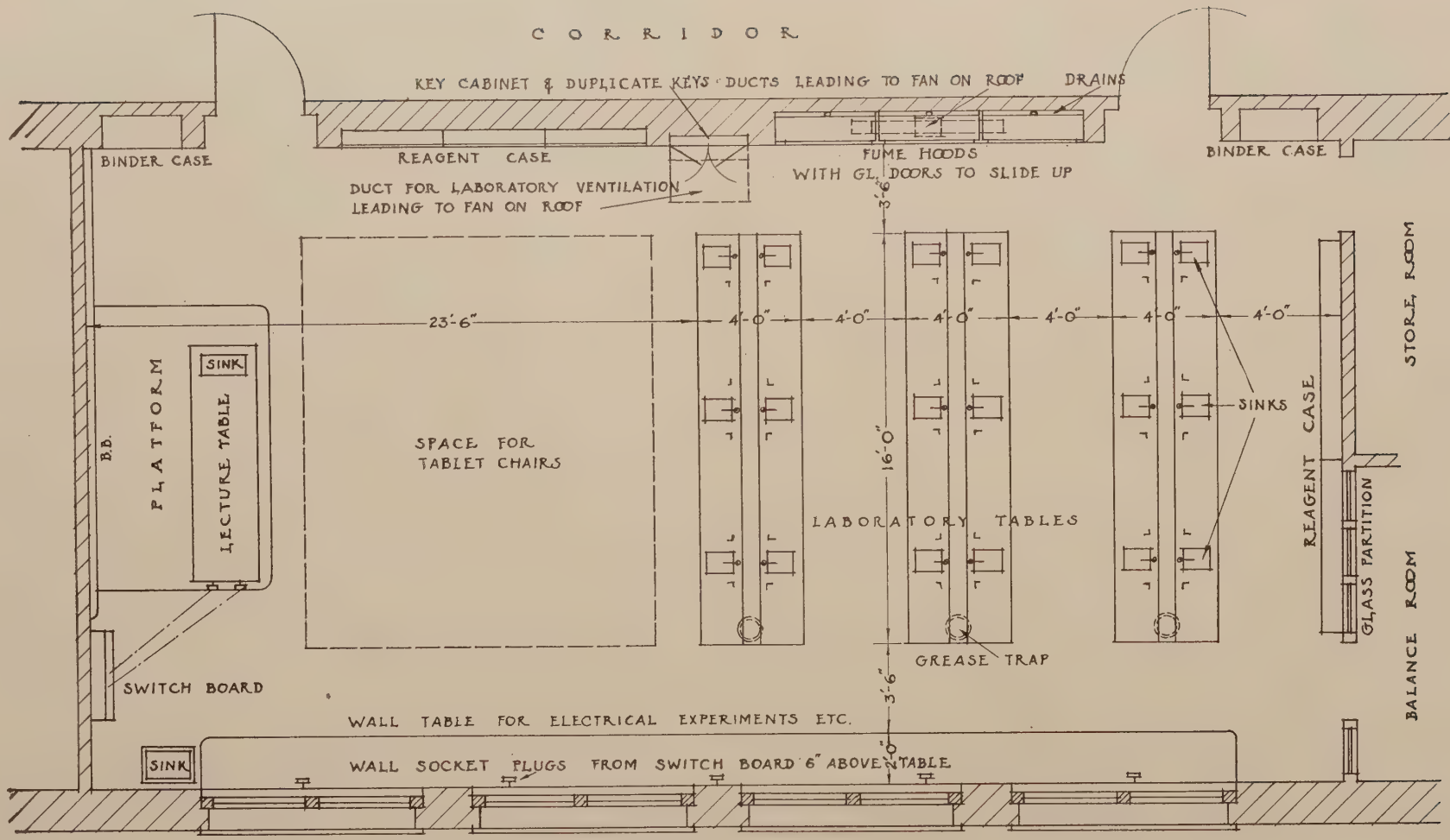
directly to the line (say 115 volts) and must be used with caution. (Touching wires will blow fuse.) If ionization experiments are to be done by the students it is a good plan to run wires from switch " A " to four or five sockets above the electrolysis table, connecting them to binding-posts as shown in the lower left-hand corner of Figure 335. These sockets may have the ordinary electric bulbs, and the student can note the conductivity of the solution by watching the glow of his lamp. The case with hinged door, covering the board, prevents corrosion of metal of switches, etc.

Laboratory Tables. — A very useful type of laboratory table is shown in Figure 336. The raised shelf provides a place for the ordinary reagents and helps in keeping acids, etc., off the table top. The tops are of wood, which is far better than any material like tile or glass because it keeps down breakage. The design calls for an unfinished top so that one of the good acid and alkali-proof finishes (as the well-known aniline oil preparation) can be applied. One distinctive feature is the use of a deep drawer which allows the student to preserve his test tubes, containing liquids, until the next period. Another is the use of the clear glass partition, preventing one student from interfering with the one opposite, allowing the teacher to see what is going on, and providing a barrier for the occasional slight explosion of a flask or tube. An improvement is to have the top of this reagent shelf of plate glass.

Each student has therefore a working space of three feet, with one gas nozzle, one clean arm or book rest, and half of one sink. Six different sections of students can use these tables. A good key system should be worked out and key cabinets (as many as there are sections) should be placed on the wall near the binder cabinets. (See Figure 335.)

Distilled water for use in experiments must be provided for, and an efficient still, gas heated, is usually the best way to get it. The plumbing for the large gas burner (for the still) as well as that for the circulating water, should be arranged for.

The Balance Room. — A balance room, at least 8′×15′, for delicate scales, should be adjacent to the laboratory, and a glass partition places it under the teacher's supervision. A quiet room is needed because draughts of air interfere with accurate work, and the room being separate can be kept free from the fumes which would corrode the balances. The subject of vibration was discussed under I (3), "Location of Rooms of Science Group." A vestibule entrance from the laboratory to the balance room is very desirable if the space is available.



PLAN OF CHEMISTRY LABORATORY

SCALE

0' 5' 10' 15'

ROOM MAY BE SHORTENED BY THE OMISSION OF TABLET CHAIRS AND LECTURE TABLE.

FIG. 332.

Mr. John J. Donovan, Architect.

FIG. 333. — CHEMISTRY LECTURE ROOM, OAKLAND TECHNICAL HIGH SCHOOL, OAKLAND, CALIFORNIA.

Where the funds available will only allow of equipping one laboratory, which must be used for both Chemistry and Physics, one or two tables on the plan of the one shown in Figure 336 and a few like that of Figure 315 will provide for experimentation by the students. If no science lecture room is planned, some tablet chairs and a lecture table like the one indicated in Figure 301 may be placed in one end of the laboratory.

V. Applied Chemistry.[1]

Planning of Courses. — In almost every high school the time for an extra year (the fourth) in chemistry can be arranged for by having the regular chemistry in the third year. In the schools where the student makes his choice of course (college or non-college) at the end of the first year, an elementary course in chemistry can be given (in addition to physics) in the second year. This allows the courses described here to be given in the third and fourth years.

Technical Chemistry. (For young men.) — *The Laboratory.* A well-lighted room is essential. The plumbing for gas and water, ventilation, reagent cases, switchboards, etc., have been mentioned previously. For this work a balance room with six to ten good balances (mounted on piers or other solid foundations) is an absolute necessity.

Any style of good laboratory table may be used, but the "individual chemical desk" shown in Figure 337 offers a number of advantages. This has the aluminum fume hood of Mr. S. E. Coleman, Oakland, California, which may be obtained in twos or in fours. The table top may be of wood (treated as previously mentioned) but as students are more experienced, may be of harder material, as vitrolite glass, porcelain, or one variety (black) of asbestos board. Storerooms, distilled water supply, etc., should, of course, be provided.

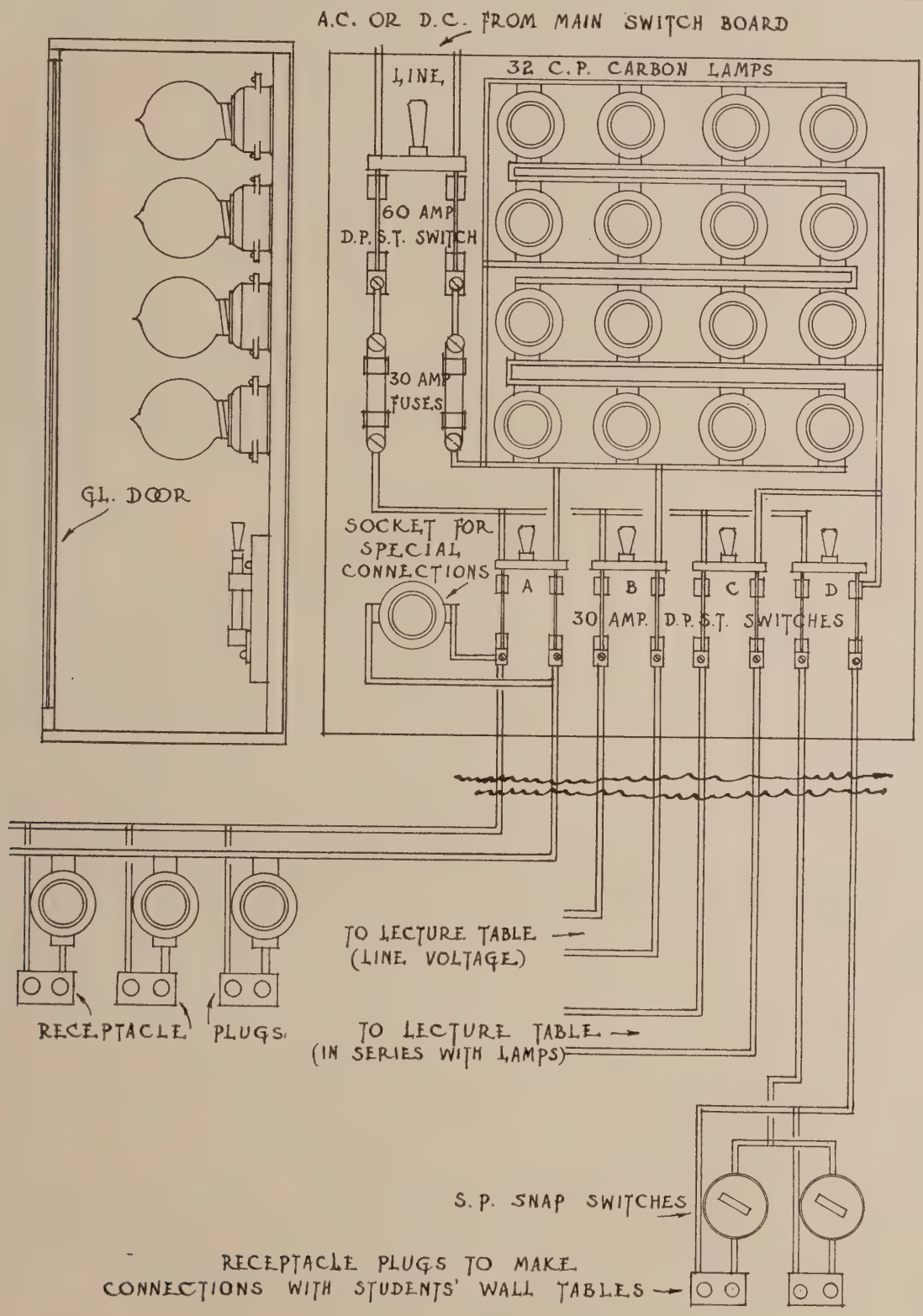
Choice of Courses. — The subject of Technical Chemistry is such a large one that only an illustrative list of the course titles can be given here. The choice should be made with due regard to the needs of the immediate community as well as of the opportunities in the state.

Suggested Lines of Work Are: Qualitative and quantitative analysis, agricultural chemistry, chemistry of

[1] Just as in the case of Physics, the college preparatory chemistry follows a somewhat standardized line of work. For the pupils who do not intend to enter college there is a broad field which is greatly neglected by those who plan high school courses of study. Those outlined here are separated into two groups, the first for the young men, the other for young women.

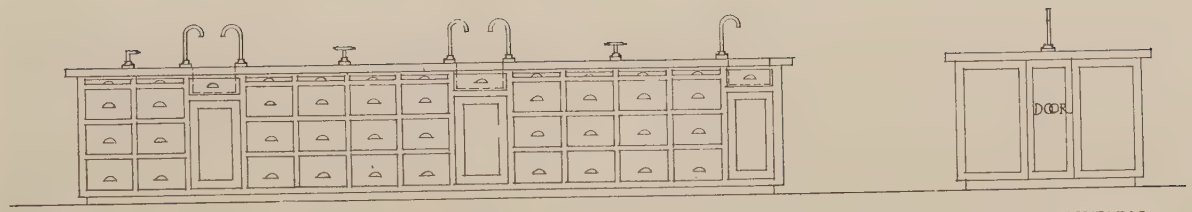
Mr. John J. Donovan, Architect.

FIG. 334. — CHEMISTRY LABORATORY, OAKLAND TECHNICAL HIGH SCHOOL, OAKLAND, CALIFORNIA.



SWITCH BOARD FOR CHEMISTRY LABORATORY

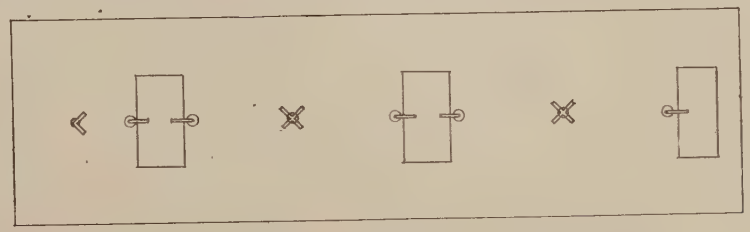
FIG. 335.



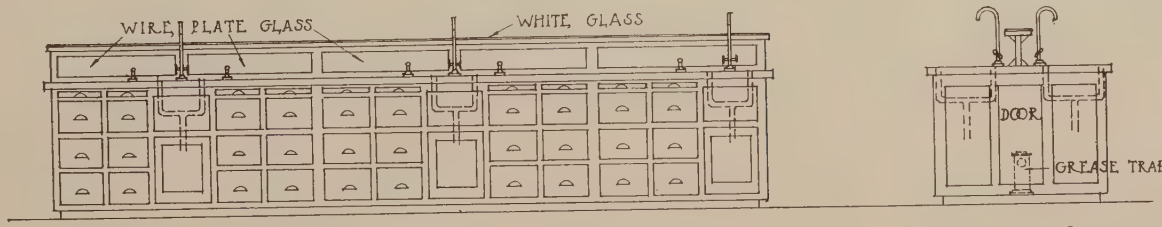
FRONT ELEVATION.

SIDE ELEVATION

CHEMISTRY LABORATORY TABLE · O.T.H.S. · OAKLAND, CAL.

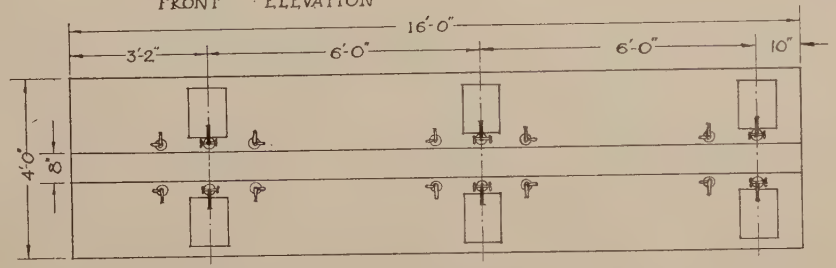


PLAN OF TOP



FRONT ELEVATION

SIDE ELEVATION



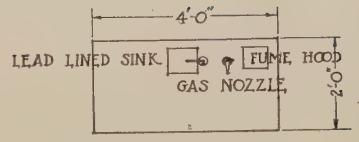
PLAN OF TOP

CHEMISTRY LABORATORY TABLE

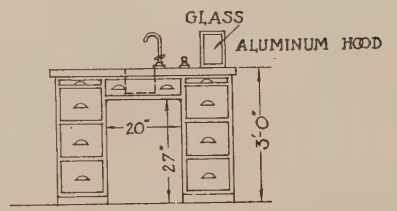
SCALE

0' 5'

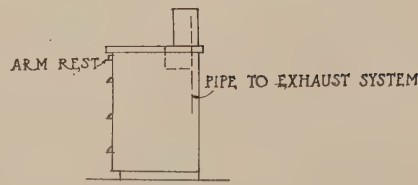
Fig. 336.



PLAN OF TOP



FRONT ELEVATION.



SIDE ELEVATION.

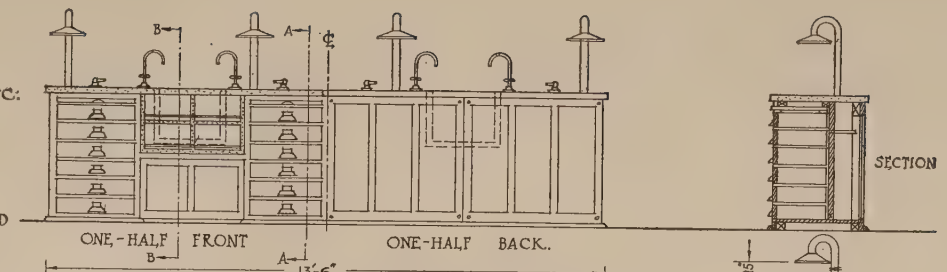
INDIVIDUAL STUDENT'S CHEMISTRY DESK.

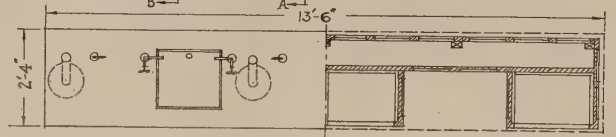
SCALE

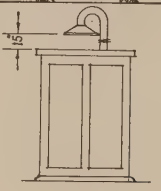
0' 5'

Fig. 337.

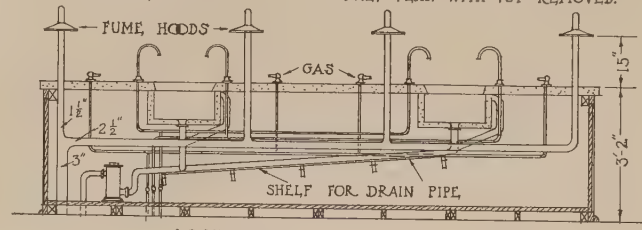
① LOCKERS
② WALL WORK TABLE,
③ STUDENTS' CASE, - FOR BINDERS, ETC:
④ WALL WORK TABLE
⑤ STORAGE CASE,
⑥ STUDENTS' TABLE,
⑦ STEREOPTICON LANTERN & STAND
⑧ INSTRUCTOR'S TABLE
⑨ APPARATUS CABINET
⑩ FUME HOODS - VENTS
⑪ WALL LOCKERS
⑫ WORK TABLE,
⑬ CARRIAGE,
⑭ APPARATUS & STORAGE CASES
⑮ WORK TABLE,
⑯ BOOK CASE
⑰ WALL TABLE,
⑱ LANTERN STAND
⑲ LIBRARY TABLE,
⑳ BOOK CASE
Ⓑ SLIDING BLACK BOARD

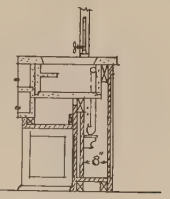


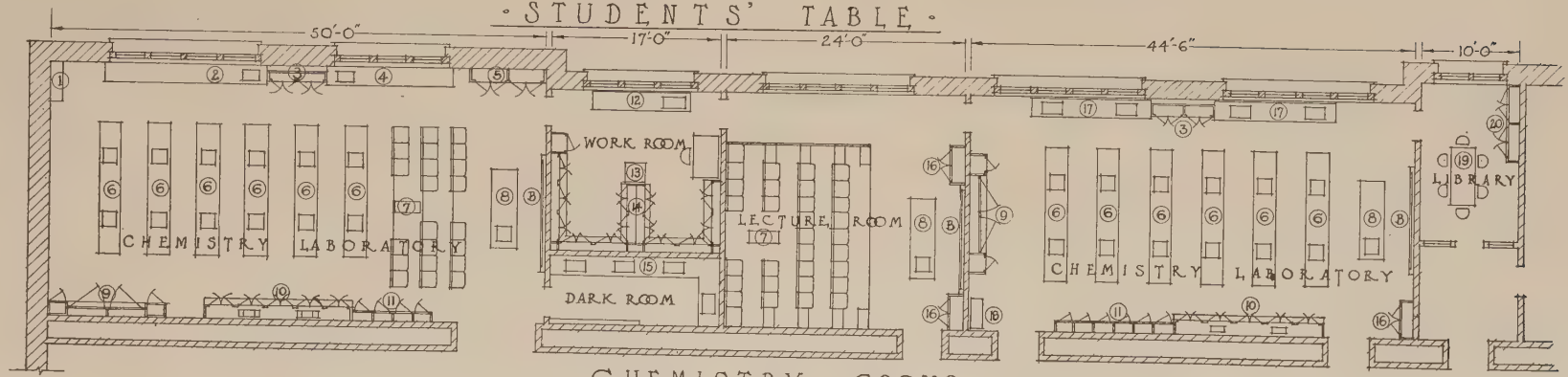




NEW HIGH SCHOOL,
MINNEAPOLIS - MINN.
W. B. ITTNER - ARCHITECT







CHEMISTRY GROUP

SCALE. 0' 5' 10' 15' 20' 25'

FIG. 338.

Mr. Wm. B. Ittner, Architect.

FIG. 339. — CHEMISTRY LABORATORY, GROVER CLEVELAND HIGH SCHOOL, ST. LOUIS, MISSOURI.

FIG. 340. — CHEMISTRY LABORATORY, SCHENLEY HIGH SCHOOL, PITTSBURGH, PENNSYLVANIA.

Mr. Edward A. Stotz, Architect.

the engine room, electro-chemistry, the chemistry of iron and steel, of glass, borax, leather, paint, dyes, fuels, illuminating and lubricating oils, foods and adulterants, coal tar products, synthetic insulating materials, wood preservatives, and other manufactures. If assaying is to be taken up, a separate room should be fitted up, with blowers, gas supply, etc., as the smoke and dust from the furnaces would interfere with the chemical work.

Household and Domestic Chemistry, the Chemistry of Foods. (Girls.) — Educators will agree that a knowledge of the life sciences (biology, physiology, etc.) is of the utmost importance to women; but there should also be a place for some instruction in chemistry for every woman who has anything to do with the affairs of the household.

If the girl enters high school only as a preparation for college she need take only the usual one year of high school chemistry; but if she is of the great majority who never expect to go to college and who drop out before completing the high school course, the work here mentioned should be of great value. It is to be started in the second year (after one year of general science) so that those who only attend for two years will be benefited. If only one additional year can be allowed in the curriculum, much good work can be done; but the responsible work of food analysis, etc., can be carried out only by young women in the fourth year, who have had two years previous training in chemistry.

Household Chemistry. (Second year girls.) — This first course must necessarily be largely on the elements of chemistry, but the teacher can find numberless applications in the households of the parents of the girls, and some of the chemistry of cleaning and dyeing textiles can be covered.

Domestic Chemistry. (Third year.) — This may well include the chemistry of soaps, the beginnings of food chemistry, a study of milk supply of cities (with the tests of butter fat and purity of milk) and the elementary portions of the chemistry of cooking.

Chemistry of Foods. (Fourth year.) — Besides the study of the composition, heat values and preservation of foods, some real food analysis can be taken up; also the chemistry of digestion, of the nutritive values of food, of food preservation, of yeasts and molds, the sanitary analysis of water, and the subject of disinfection.[1]

Lighting of Laboratories Used for Evening Work. — The light for most laboratory work should be nearly as strong as that for mechanical drawing, and the lighting fixtures, etc., should be planned by an illuminating engineer.

Technical Education for Adults, for Crippled Soldiers. — Grown people who have been denied educational opportunities in youth, or who are forced to change occupation, can benefit from these courses when they are put before them, as by university extension or other evening-school plans.

It is hoped that the courses may also aid greatly in the rehabilitation of and finding occupation for returned army and navy men incapacitated for their former work. (*E.g.* armature winding is now being done by blinded men.)

One Forcible Lesson from the War. — The inconvenience and the danger of our hastily organized emergency war instruction in technical subjects as a part of our war effort, and the hurried search for places and equipment to give such instruction, should impel us to greater efforts in the direction of better technical schools. The excellence of the European technical schools has been known to educators for a long time. Let us hope that the lesson will not be forgotten, and that schools giving such courses will be so strongly demanded by the people that there will be many finely equipped ones instead of those now conspicuous by their scarcity.

[1] These subjects overlap the field of dietetics, commonly given in the "domestic science" department of the high school, but the dividing line can be sharply drawn by deciding that the work requiring a chemical laboratory for its performance is chemistry, and that which does not may be properly included in the other departments. The latter may be labeled the "household arts" department, or perhaps some title can be found which does not include the word science.

CHAPTER XIX

THE GENERAL SCIENCE AND BIOLOGICAL LABORATORIES

By Edna Watson Bailey, Ph.D., *Head of Science Department, University High School, Oakland, California*

I. Development of General Science and Biological Laboratory. II. Function of the Laboratory. III. The General Science Laboratory Plan. IV. The Biological Laboratory. (1) Its Function. V. Botany, Zoölogy, Physiology, Agriculture, Hygiene and Sanitation. VI. Biological Laboratory Facilities. VII. The Laboratory Plan. (1) Storerooms. (2) The Menagerie. (3) The Microscope. (4) Bacteriology. (5) The Outdoor Laboratory.

Development of the General Science and Biological Laboratory. — Secondary education in science to-day is breaking away from academic ideals and developing in the direction of community usefulness to an extent which is bound to influence materially the planning of laboratories. The growing tendency to make the school a community center, functioning in the practical and spiritual concerns of the community, and the increased emphasis on vocational guidance and education, demand provision for practical work in applied science. The modern high school laboratory must make possible the release of the student's initiative and his creative instinct in constructive work recognized by himself as worth doing. Good work of this sort can be and has been done in the old-fashioned laboratory, but under great disadvantages.

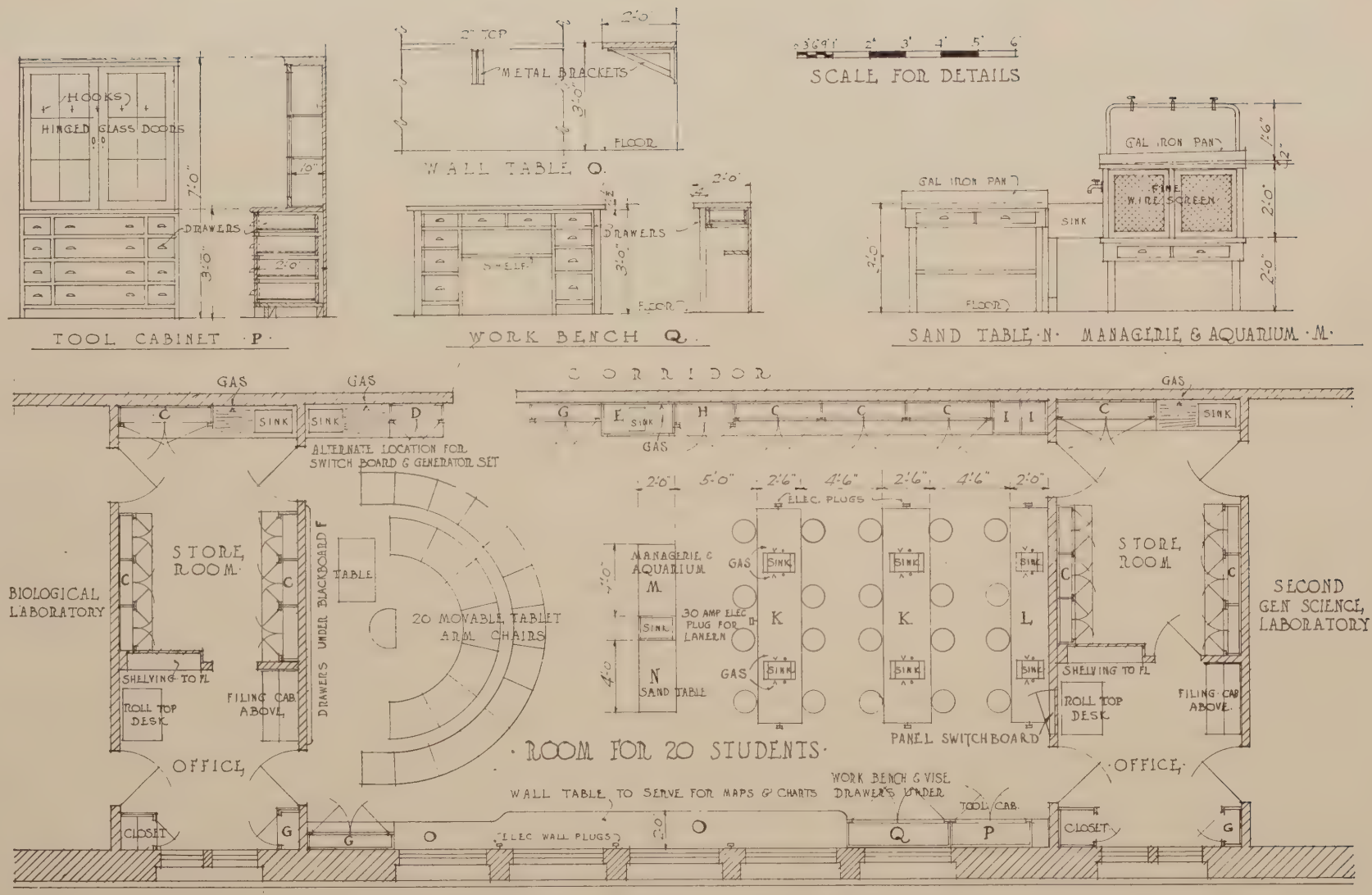
Function of the Laboratory. — The ideal laboratory has as its function the setting free of the student from limitations of material convenience. First, he must be free from his teacher, independent as far as possible of her aid in securing materials and doing work; second, from his class, able to work out his own problems without interfering with or being hampered by his neighbor; and finally, he must be freed from the limitations of any one specialized science, free to use the material of all sciences as far as he needs it, and can command it.

On the first point, Mr. Hodgdon,[1] a leader in the teaching of general science, has this to say: "In no part of school work is more practical psychology required than in the teaching of science. One of the chief faults of a teacher is to dominate a class. — The ideal place for a teacher is an out-of-the-way place in a classroom, trying to keep still."

The average laboratory is very poorly provided with places for teachers to keep still in. The prominent "teacher's table" or "demonstration desk," usually the best equipped table in the room, often the only one provided with gas and water, shows all too plainly who is to be the "star performer" and who the audience. Since the teacher is to do the work, supplies and equipment are stored for his convenience, usually in locked cases, in a locked room. There is usually a lecture room between two or more of these "laboratories." Here recitations are conducted, and demonstrations given by the teacher. Such a plan presupposes that the teacher will not only originate the work, but also perform most of it. But the problem to-day is, how can a laboratory be planned to accommodate a class which is not dominated, but guided, by a teacher?

While the details will vary with local conditions, there are certain characteristics of plan and equipment which will be found desirable. The common laboratory tools and supplies should be brought out of the locked storeroom and placed in cases along the walls where they will be most readily accessible to the greatest number. Since the problems and methods of work of the class are to be such as originate in the class, there must be provision for class conference of the "round-table" sort, and obviously the number of students who can profitably participate will be smaller than the number that can play audience to a teacher's performance. In such a plan, there is no place for a rigid division into "laboratory days" and "recitation days," but laboratory work and recitations are fused by the conception of a class accomplishing its purpose by all the means at its disposal. It is desirable to have this class conference in the room which is equipped for laboratory work. Does the modern science department have use then for a lecture room? Yes, indeed, for there are many people in any community from whom science classes can learn much, and a good lecturer will have an eager audience.

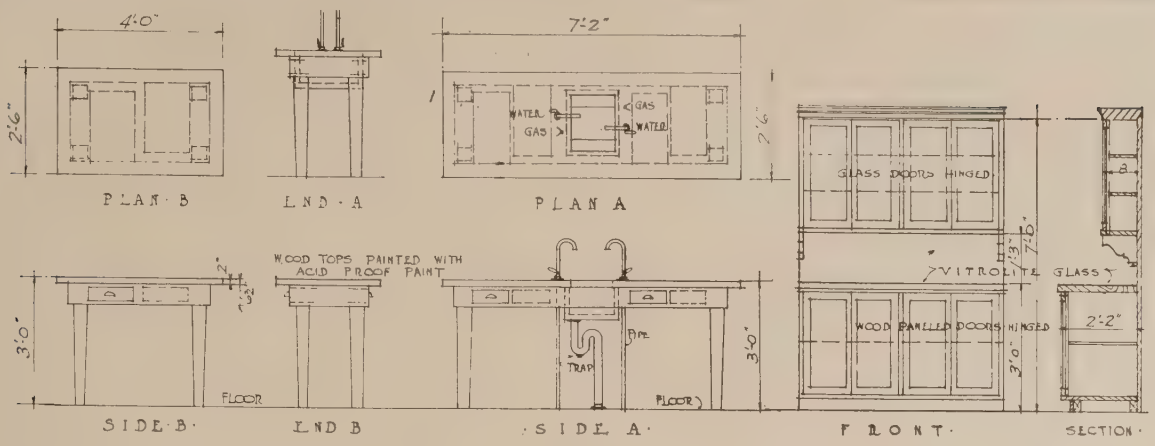
[1] Mr. D. R. Hodgdon, *General Science Quarterly*, January, 1919.



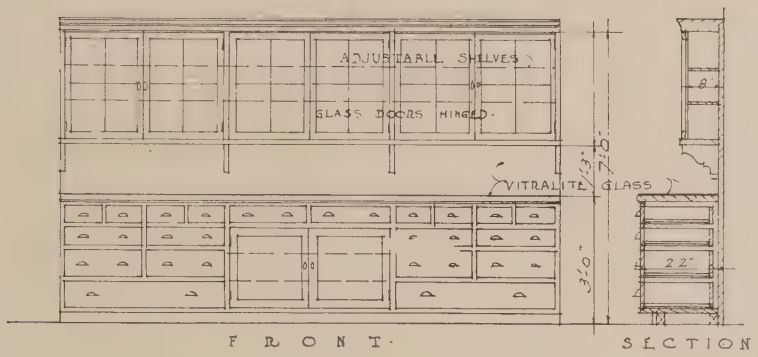
FLOOR PLAN OF THE GENERAL SCIENCE AND PHYSIOGRAPHY LABORATORY

SCALE

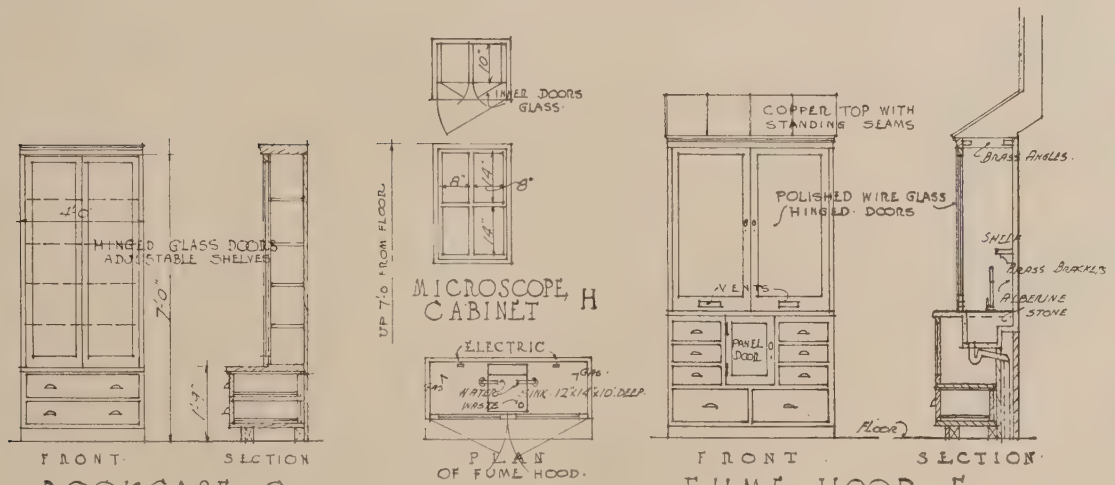
FIG. 341.



·TABLE B· ·TABLE A· ·EXHIBITION CASE D·



·SUPPLY CASE C·



·BOOKCASE G· ·FUME HOOD E·

DETAILS OF EQUIPMENT IN GENERAL SCIENCE, PHYSIOGRAPHY AND BIOLOGICAL LABORATORIES.

SCALE.

FIG. 342.

The preparation of special topics with accompanying demonstrations by members of a class has become an important part of science work as directed by some of our best teachers, and these student lecturers command respectful hearing from their mates. Since an audience may be many times as large as a class conference group, a science assembly room is needed and replaces the old fashioned "lecture room." It has so many possibilities of school and community service, inter-class and inter-school work, vocational guidance and co-operation of the school and the business world, that it contributes greatly to the living efficiency of the school.

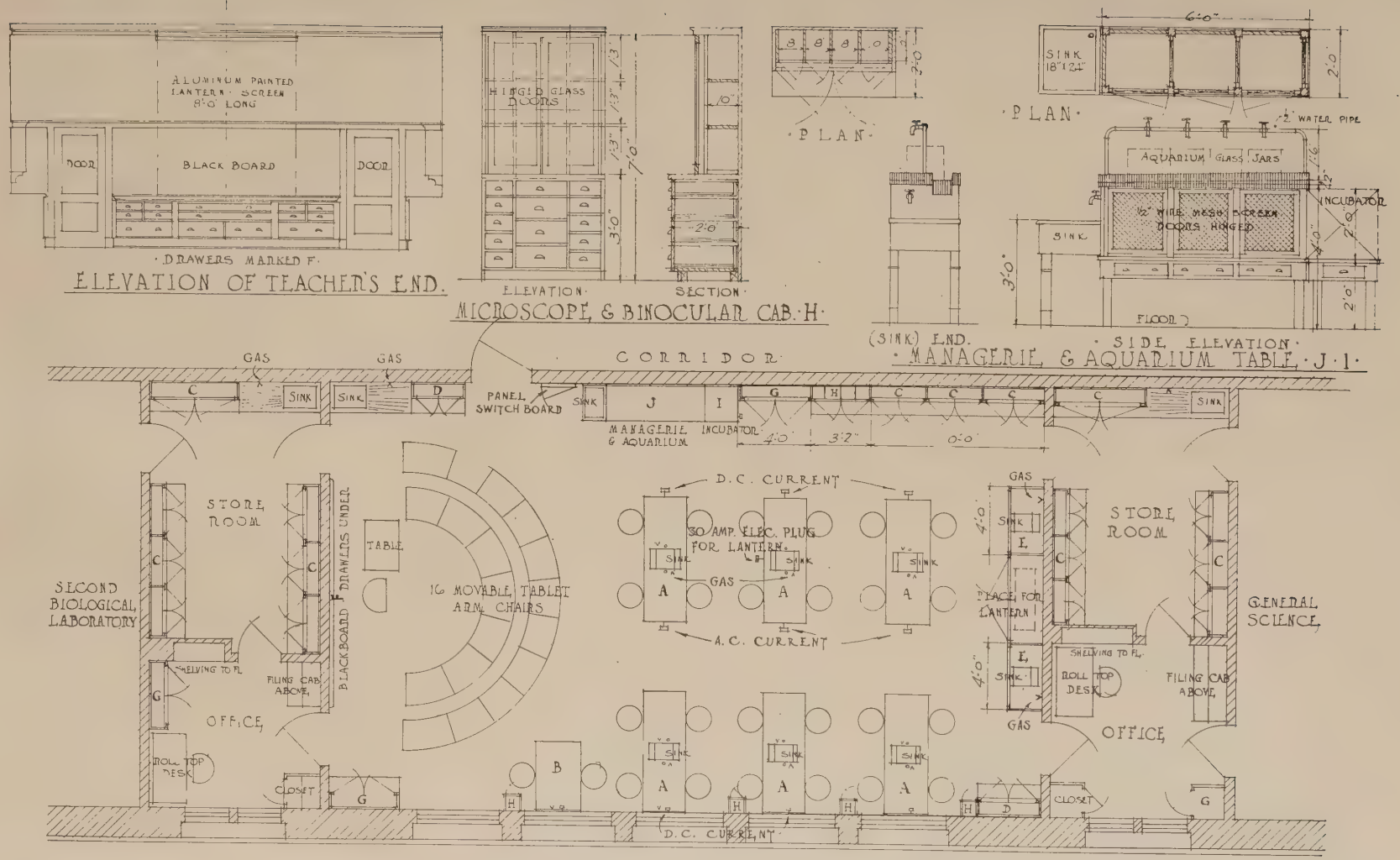
The second demand, concerning the liberation of the individual from the group, is not satisfied by the usual type of general science laboratory. The long tables, with materials stored at some remote and inaccessible point, are suited to a group of pupils all working under direction at the same task. The new laboratory must make provision for individual activity as far as possible, and for hobbies. This means tables designed to provide a unit of laboratory equipment of gas, water, and electricity to not more than four students. Where the single or double table plan is adopted, it generally means providing no equipment at the table, because of the expense of individual plumbing, etc., but gas, water, and electricity must be provided somewhere in the room. This is not as satisfactory as planning on the basis of a four-student group.

Books, microscopes, work-bench, tools, all must be as accessible as possible, in order that the class may not impede the individual, nor the individual disturb the class. Provision for hobbies involves facilities for making and caring for all sorts of collections and exhibit-cases for their display, good equipment for photography, provision for work with living plants and animals, and a well-equipped "tinker shop" with tools, lumber, and a generous supply of raw materials for chemical, mechanical, and electric projects.

Finally, the modern laboratory for general science must be free from the limitations surrounding the laboratories designed for the special sciences. Any high school general science laboratory which does not provide the facilities for making use of chemical knowledge in education is hopelessly inadequate. The same is true of physical and biological equipment. Microscopes are only an unwieldy one-eyed sort of magic spectacles, at once an aid and a powerful stimulant to the imagination, and so should be available to all curious youngsters. The tools of the bacteriologist also belong to all classes. Instruments for weighing and measuring, simple machines and mechanical devices, electrical equipment — the tools of physics are also indispensable.

To sum up the characteristics of our ideal general science room: It will have developed a laboratory arrangement that facilitates group activity and provides for individual initiative; it will be so equipped as to set students and teacher free in the realm of the fundamental sciences, supplying the essential tools of them all; it will provide tools in abundance, of the same sturdy excellence as those with which the work of the world is done, but will eliminate playthings and toys masquerading as "apparatus"; and it will provide abundant material and opportunity for creative activity.

The General Science Laboratory Plan. — A plan which embodies the ideals set forth is shown in Figure 341. The semicircle of chairs at one end of the long room, facing the blackboard, gives opportunity for class conferences, or individual work with reference material from the nearby bookcases (G), a sink to the right, and a fume hood (E). Microscope lockers (H), and storage cabinets (C) provide a ready access to demonstration material. An exhibit case (D) shows in a prominent and well-protected place work done by groups or individuals, material collected or loaned, models, etc. This case should serve as a bulletin board or "show case" of the fruits of the various class activities, and should be a center of interest to the whole school. Under the blackboard shallow drawers (F) provide storage space for charts and other material likely to be needed. The laboratory tables (K) provide two sinks, ample gas connections, and electrical outlets, and will accommodate eight students at each table. Another arrangement of facilities for using gas and water is shown in Figure 344, consisting of a lead-lined trough running the full length of the table and emptying into a deep sink at one end. This is preferred by some, while others find many disadvantages in it. It does not provide as satisfactory facilities as does the arrangement shown in (K), but is less expensive. The deep sinks shown in (K) avoid spattering, serve as pneumatic troughs, and are useful in so many ways that the expense seems abundantly justified. Along the side of the room, under the bank of windows, a 24″ wall-table (O) provides a well-lighted table space for use of maps, making of diagrams, etc. At the end of the room farthest from the conference group, a work-bench (Q) and tool cabinet (P) are shown. Across the room, in a corner removed from drafts, and accessible to the storeroom, are placed two electric incubators (I). Between the laboratory tables and the set of chairs are provided a sand table (N) and a place for keeping living plants and animals. The sand table needs no special description; the "menagerie and aquarium" (M) is perhaps not quite so familiar to the reader, or so readily understood from the detail. It consists of a case with a zinc or galvanized-iron top, sloping toward the sink



FLOOR PLAN OF THE BIOLOGICAL LABORATORY.

FIG. 343.

(6″ in 4′) and protected at the sides by a four-inch curb. Above this runs a ¾″ water pipe, equipped with several cocks. This is designed for the accommodation of a number of small aquaria, vivaria, ter-aquaria, and potted plants. Under classroom conditions, many small aquaria, easily supplied with running water, have been found more useful and more successful than the very large single aquarium. Beneath this table are four compartments 2′×2′×1′, their walls made of ½″ mesh screen, and their floors of zinc-lined removable drawers. The base of these compartments should be about 2′ above the floor. Everyone who has noticed the universal human interest in living creatures, and repugnance for dead ones, will appreciate the possibilities of such a "live-table," as a storage place for the living material which students will bring. It is desirable to provide as much free space (at least 5′) around this unit as possible, in order to have free access to this material.

Such a room would provide a real workshop for the projects of a class of normally enthusiastic young people. Though designed primarily for the general science of the junior high school, it would serve for physiography, botany, zoölogy or geology in the senior high school, and could readily be adapted to instruction in any secondary science.

The Biological Laboratory. *Function.* — Biology in the secondary schools has had a checkered career. It first appeared in the time of Huxley and Parker as a study of "types" of plant and animal life. Its inspiration was the Darwinian thesis, and its mission the presentation of that thesis. The chief function of the course was to teach the theory of evolution by means of the facts of comparative anatomy, embryology, and paleontology, which constitute its basis. It was planned by great teachers, and it met an enthusiastic reception because it filled a real need in public education. The conception of organic evolution was a revolutionary one, and civilization halted until it could be assimilated and incorporated into the spirit of the times. How effectually this was done, the attitude of the present generation bears witness. There are no more arguments as to the doctrine of "descent with modification," though there is some discussion as to the laws governing this descent. But the conception of a living world continually creating a new world, of "*l'évolution créatrice*," is implicit in our twentieth-century thinking. For the rapid diffusion of this point of view, we have to thank biologists like Huxley and Parker and the "type courses" they promulgated. Such courses, being concerned chiefly with comparative structural studies, needed little in the way of laboratory provision, beyond a table of the proper height for microscopic work and dissection, and storage facilities for material and tools. Such laboratories were planned and built, and one is tempted to think that builders of schools have not thought clearly concerning biological laboratories since the days of Huxley.

The science of biology has traveled far in the intervening decades, and educational aims and methods have advanced even more rapidly. On one hand biology in the strict sense of the term is concerned chiefly with the physical chemistry of living stuff, and therefore, requires the facilities of a chemical laboratory. On the other hand, biology as a school subject is becoming more and more the study of relations among living creatures, especially between man and his living environment, with reference particularly to advantages and disadvantages resulting therefrom for his health and purse. The phrase "civic biology" used as a title by two of the most recent texts [1] indicates the direction of the work. Biology of the modern academic type then demands as complete a laboratory equipment as do physics and chemistry, in addition to the strictly biological apparatus; while civic biology concerns itself with the great outdoors and community conditions primarily, such as infectious diseases, water supply, sewage disposal, forestry, game, etc., and also with the relationships between living creatures, as far as a miniature world can be maintained within laboratory walls. Furthermore modern education aims at tangible results: things to be done, created, improved, accomplished by the student. And for that reason we find the same necessity for tools and working facilities in a biological laboratory as we met in planning the general science laboratory. The fact that we are working with living stuff, demanding exact conditions and unusual facilities for care, makes the selection and provision of this equipment more difficult.

Botany, Zoölogy, Physiology, Agriculture, Hygiene, and Sanitation. — Aside from the courses labeled "Botany" there are found in secondary curricula specialized sciences belonging to the biological group; in the realm of pure sciences — botany, zoölogy, physiology; and in applied sciences — agriculture, including plant and animal husbandry, hygiene, and sanitation. As specialized sciences, botany and zoölogy are giving way in many schools to applied or more generalized sciences. Where they are retained, they tend to develop into economic botany and zoölogy, in response to the demands of the time. Laboratory accommodations which are adequate for biology will be satisfactory for this work also, and will permit the expansion of old-fashioned systematic

[1] Hunter's *Civic Biology*, American Book Co.
Hodge and Dawson, *Civic Biology*, Ginn & Co.

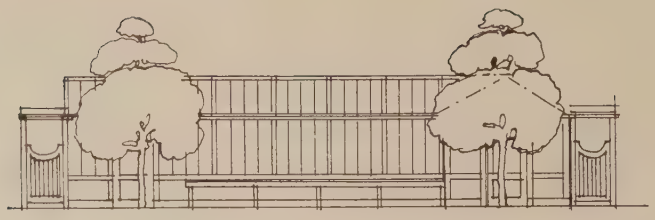
Mr. Edward A. Stotz, Architect.

FIG. 344. — GENERAL SCIENCE LABORATORY, SCHENLEY HIGH SCHOOL, PITTSBURGH, PENNSYLVANIA.

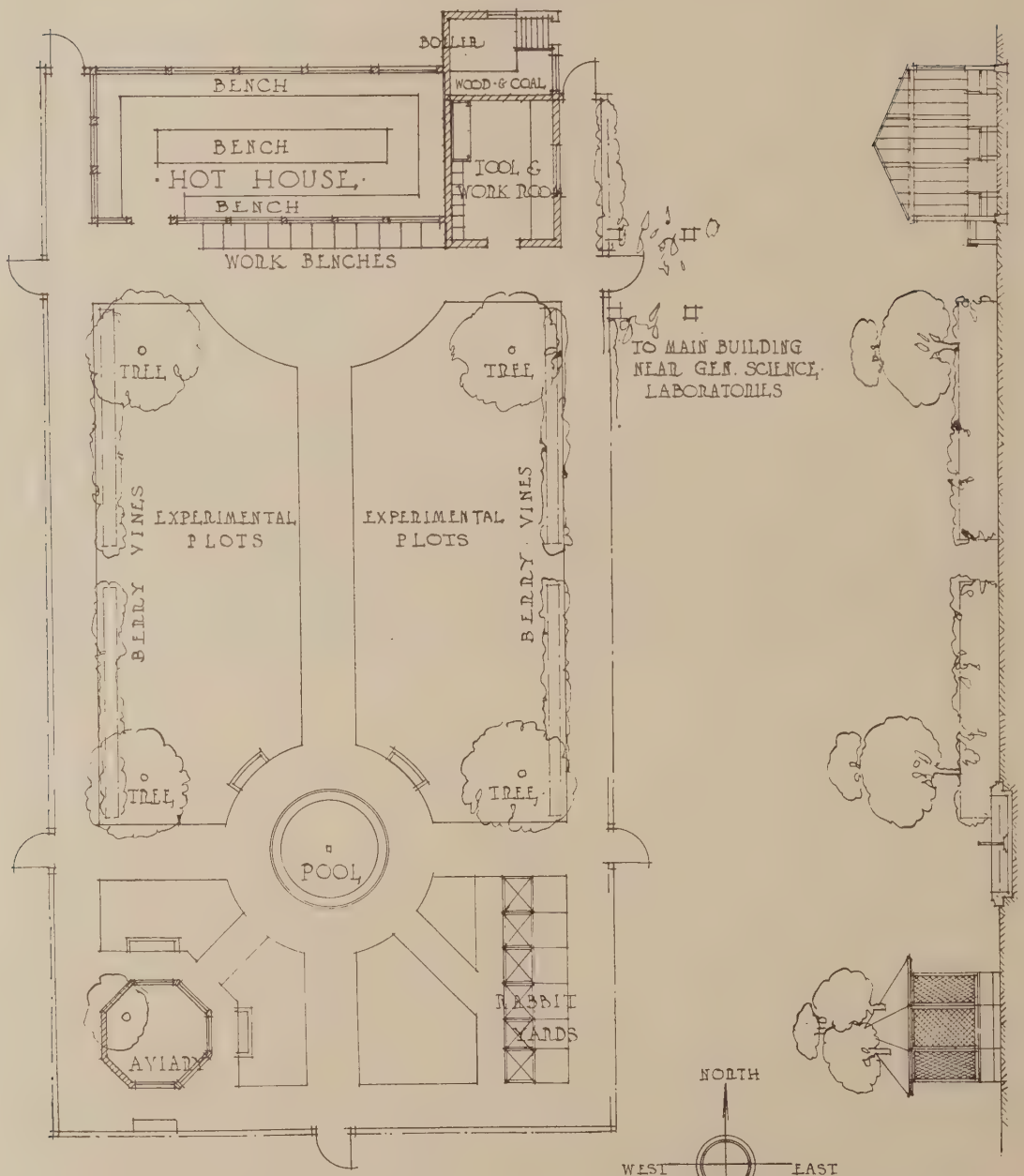
work into something more nearly akin to every-day needs. So far as "physiology" is concerned, the word probably stands for more kinds of courses, less standardized, than are found under any other one high school subject. If given in the first two years of the high school, it approaches in content a general biology course, with emphasis on the human aspects. Where given in the last two years, it may be almost anything from text-book work in anatomy and physiology, to a well-organized course in general physiology, and hygiene, in the stricter sense of the words. For the former course, no laboratory is needed; for the latter, a well-equipped biological laboratory is adequate.

As regards the applied sciences, elementary agriculture can be accommodated in a laboratory of the general science type; in schools where this work is more completely developed, especially designed laboratories will be needed. Hygiene, taught as a laboratory subject, demands the same provisions as does biology.

Biological Laboratory Facilities. — To the thoughtful student of secondary education, it is very apparent that the sciences, pure and applied, are in a state of transition. We shall never again have a formal academic division into specialized fields, any more than we shall go back to organization of our courses on the basis of text-book work. There will be constantly increasing efforts to afford opportunity for creative work by students, and thereby a chance for individual and community betterment as a concrete result of this work. It is not an easy matter to plan a laboratory to fit exactly the needs of a class in biology ten years hence. But since school buildings are not built for a day, but for a generation, it would seem to be the part of wisdom to build a generalized biological laboratory in which all the essential tools of the special sciences are available, where classes and teachers will enjoy the greatest freedom in selecting problems and solving them.



·ELEVATION OF HOT HOUSE & TOOL ROOM·



·PLAN OF GROUNDS·

OUTDOOR BIOLOGICAL LABORATORY

·LONGITUDINAL SECTION·

FIG. 345.

Such a laboratory should offer:

(1) Gas, water, electricity conveniently available for units of two to four students each.

(2) Facilities for use and convenient storage of microscopes and accessories.

(3) Provision for keeping plants and animals under observation in the laboratory.

(4) Provision for plant and animal experimentation and cultivation on a scale impossible within the laboratory.

(5) Provision for free class and individual activity.

The Laboratory Plan. — While the details of plan and equipment are bound to vary with local conditions and teachers, it is hoped that the accompanying lay-out of such a laboratory, suited to any of the biological group of sciences, may be of assistance. (See Figure 343.) A room about twice as long as wide, with its long axis east and west, in order to obtain north orientation, offers the most attractive possibilities for development. The general plan requires a laboratory and classroom in one, and does not demand a separate lecture room except where large groups of students, including several classes, are to be accommodated. One "science assembly room" as described in the discussion of the general science laboratory should be available for the use of the science department.

There are unusually good opportunities for correlation in the work in biology with the needs and activities of the community. This may often be greatly aided by talks by men and women who are working in some of the many fields of applied biology, and by reports of community projects carried on by individuals or groups from the school itself. For biology especially it is true that the community is the laboratory, not merely to add interest and vividness to the school work as in the inorganic sciences, but to be itself the chief material of the school work in this field. In any true understanding of the social function of biology, what goes on in the schoolroom is only for the sake of what can be accomplished in the life of the neighborhood. Therefore, it will be assumed that some room will be available for the larger assemblies which are so necessary to this work, and the plan under discussion will provide only for the small class group, preferably not more than sixteen to twenty pupils.

An informal grouping of tablet-armchairs at one end of the room (Figure 343) offers opportunity for class discussion or for individual work, and is helpful in stimulating the class and placing it on a socialized basis. It also deposes the teacher from his undemocratic eminence behind a "lecture table." An adjoining storeroom makes for convenience in the preparation of demonstrations by students. An exhibit case (D) with glass shelves, and a set of drawers below, provides facilities for displaying class productions, individual collections, loan exhibits, etc. A bookcase (G) brings reference material within immediate reach of the class. Drawers (F) underneath the blackboard supply facilities for storage of charts, maps, picture collections, and similar material.

Storerooms. — The storeroom, opening to the right of this blackboard space, is provided with gas, and water, and storage cabinets of the type "C" used in the general science laboratory. While the storeroom is rather small ($12' \times 15'$), so much of the material ordinarily kept in a storeroom is provided for in the main laboratory that this amount of space should be adequate for all material that is really needed for class work. Storerooms so readily become junk yards, that this limitation in size sufficiently strict is desirable to prevent accumulation of any material not in good repair and frequent use.

In addition to the storerooms belonging to each laboratory, the science department should have a "science warehouse" or storage room where reserve supplies and material infrequently used could be kept. Such a storage room could be in the basement or attic, though it is more convenient if on the same floor with the laboratories. Experience has demonstrated the advantages of such a place. When the greater part of the experimental work of a class is turned over to the class itself, free access of students to the laboratory storeroom follows. It has to be established that basic laboratory supplies are primarily to be used, not kept; and should be so stored as to be both safe and accessible, if possible, but certainly accessible. But while a modern science class has less and less need for elaborate and expensive apparatus, too good for anyone but the teacher to handle, there still remains an apparently irreducible minimum of instruments of precision, models and special pieces occasionally necessary, which cannot be left to the unsupervised use of adolescents, who are constitutionally careless however good their intentions. Also, there should be safely stored a surplus stock of basic supplies, upon which the department draws as needed.

The Menagerie. — Any real biology class enjoys working with living material, and with the slightest encouragement will bring it in quantity. Such material should be available for class study first, and then housed on the school grounds for further enjoyment and work. This calls for two kinds of provision: first, a "menagerie" within the classroom, and second, an "out-door laboratory." The "menagerie or live-table" should be so placed as to permit of free observation. It should receive only north light and not too much of that; enough for growing ferns is a rough criterion. It should

Mr. Wm. B. Ittner, Architect.

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FIG. 346. — CONSERVATORY, GROVER CLEVELAND HIGH SCHOOL, ST. LOUIS, MISSOURI.

Mr. Wm. B. Ittner, Architect.

FIG. 347. — PHYSIOLOGY LABORATORY, GROVER CLEVELAND HIGH SCHOOL, ST. LOUIS, MISSOURI.

not be placed near radiators. No animal can be expected to live under cramped and noisy limitations very long, but they can be kept long enough to gratify the curiosity concerning them and to raise a number of questions to be more fully answered by later painstaking study under the conditions of the outdoor laboratory. The live-table is of the same general construction as that described in connection with the general science laboratory, but should be somewhat larger.

The Microscope. — The storage and distribution of microscopes is a problem upon whose correct solution a good deal depends. The requirements of a good storage place are (1) freedom from dust and dampness, (2) provision for keeping each microscope separate from its neighbors, to avoid injury to fine adjustments and lenses, and (3) such an arrangement as will obviate as far as possible the danger of knocking the microscope against anything as it is returned to its place. A microscope is heavy, and a blow or a fall usually necessitates an expensive trip to the factory for repairs and readjustments. The detail of the case "H" shows a design which meets these requirements. Separate compartments with glass doors, within a large cabinet, guard against dust and moisture, and prevent one microscope jamming another. The case has been kept low enough so that the top shelves are within easy reach of young people. One tier of compartments has been made wide enough to accommodate the binocular type of microscopes, a few of which should be found in every well-equipped laboratory. It is not wise to extend the compartments to the floor, as it has been found that handling the microscopes at this low level is conducive to bumping and jarring of instruments. There is special danger of jamming the draw tube down into the stage as the microscope is withdrawn from the compartment near the floor. Therefore it has been found desirable to utilize the space below a convenient level — about 3′ from floor — for a series of small drawers in which microscope accessories, collections of slides, tools, and materials may conveniently be stored.

The function of the microscope in biological teaching has become less formal and more incidental, less an end in itself and more a means to better vision. To fulfill this purpose, it is essential that the instruments be readily available to individuals, even if the class as a whole has not been directed to use them. A system that has been used with a good deal of success, indicated on the plan of the biological laboratory (Figure 343), consists in placing small two-microscope cases between the windows near the tables "A" and "B." These cases are of the type "H" described above, and contain also a small drawer for accessories. It is found that a few of these readily accessible instruments greatly stimulate the use of the microscope, and help to develop in the

exceptionally good student with a definite scientific bent, a real mastery of the instrument. The tables "A" need no further description than can be obtained from the detailed drawings (Figure 342), table "A." No drawers or lockers have been shown under the students' tables, as these will vary with local conditions and methods of conducting the laboratory. At the rear of the room are placed two fume-hoods (E) with sinks and gas connections. Between these is a cabinet for storage of the projection apparatus and its accessories.

Bacteriology. — In all modern work in high school biology the emphasis on civic interests has brought forward very prominently the subject of bacteriology. For any intelligent comprehension of bacteria and their ways of living, actual individual experimentation is indispensable, and facilities for this must be provided in the laboratory. Sterilizing may be carried on in Arnold steam sterilizers and pressure cookers, but to insure the growth of the organisms an incubator (I in Figure 341) must be available. This should be of the electric type, and should be placed in a sheltered recess, easily accessible to the class.

The Outdoor Laboratory. — The "outdoor laboratory" (Figure 345) is an indispensable adjunct to the equipment necessary for a satisfactory study of biology in secondary schools. Field trips, excursions, home projects, while highly desirable and very useful, cannot take the place of proper outdoor provision on the school grounds for practical biological work. In cold climates a greenhouse is a necessity, and even in California it is a decided advantage. This "outdoor laboratory" has been designed to meet the universal human interest in living, growing things, and to provide simple facilities for the wealth of experimental work which classes if given this opportunity will suggest and perform. It is of far greater usefulness and importance than any indoor laboratory, and where both cannot be afforded, provision should certainly be made for the outdoor one first. There might be almost indefinite extension of the plan, but there should be no reduction below the minimum here shown.

The conservatory, the tool-houses, and the work-benches need no further description than the plans afford. The experimental plots should have some growing trees and shrubs, which will become more and more an asset with time. Hardy berry vines, such as blackberry, loganberry, etc., and shrubs, such as currant, gooseberry, and ornamental shrubs suited to the locality, should be planted around the border of the plots. These will furnish excellent material for practice in plant propagation and opportunity for fighting of pests. Toward the far end of the laboratory, shrubbery should be massed to make a protected corner for the pool, the rabbit hutches, and the aviary. The pool should be large enough to support a considerable variety of aquatic life, and if nothing else in the whole plot can be secured, the pool by all means should be built and maintained. It is a world in little for the biologist, never the same two months or even weeks in succession, an inexhaustible source of fascinating material.

The aviary should be octagonal in form, four of its sides and the roof being built solid to protect the birds from penetrating winds and weather, and the other four sides of sunny exposure should be covered with half-inch mesh galvanized poultry wire. The floor must be made rat-proof. A shrub or small tree growing within its walls is a very desirable addition. Drinking fountains, feeding troughs, and nesting boxes, all furnish opportunity for student construction. Rabbit hutches, which may be used for other small rodents, also, may well be placed in this sheltered part of the plot; in cold climates they will need to be provided with warm quarters.

Around the pool and near the aviary, concrete benches will provide a place for embryo naturalists to loaf. The entire "outdoor laboratory" should be surrounded by a dog-proof and boy-proof fence, with a gate that can be securely locked. It would be desirable, where feasible, to have the conservatory adjoin the biological laboratory, opening out from it.

In schools where agriculture is taught extensively, a school farm should be available, and coöperative use of it by the departments of agriculture and biology will be of mutual benefit. Where only the minimum essentials of agriculture are dealt with, the "outdoor laboratory" could be used by the two sets of classes and to the advantage of both. Such a plot as this has great value in making concrete the suggestions of the classroom work, and affords an opportunity for neighborhood demonstration of school work.

It will be found that no investment a community can make will yield better returns than the provision of ample and modern educational facilities. It costs more to teach by means of laboratories and shops than from books, but it is worth more. Such teaching under the best conditions pays dividends of health, initiative, and resourcefulness, of hands trained to execute the fertile conceptions of the trained minds; it leads the school out into the community, and draws the community into the school.

CHAPTER XX

COMMERCIAL DEPARTMENT

By Reginald R. Stuart, *Principal Oakland Technical Continuation High School, Oakland, California*

Functions. Educational Experimental Laboratories. Relation to the School in General. Location in Plant. Organization of Department. Heads of Department, Duties, etc. First Floor Plan. Department Offices. Filing System. Psychological Tests. Placement Bureau. Keys. Auxiliary Telephone Switchboard. School Bank, Functions. School Bank, Organization and Equipment. School Store. Supplies. Advertising and Salesmanship. Continuation Courses. General and Specialty Salesmanship. Model Shop Window. Junior Chamber of Commerce. Office Training. Job Records. Student Secretaries. Principals' Secretaries. Bookkeeping. Farm Accounting. Household Accounts. Office Practice. Bookkeeping Desks. Maximum Use of the Plant. Continuation School. Evening School. Typing. Typing Desk. St. Louis Typing Room. Typewriters, Care and Repairs. Calculating Appliances. Second Floor Plan. Teachers' Offices. Stenotypy, Radio, etc. Typewriters, Selection. Commercial Geography. Laboratory Material. Filing Equipment. Commercial Exhibits. Recitation Rooms. Modifications of Plan. Standardized Plan, New York City.

Functions. — The primary functions of the commercial department of the high school are to offer specific training for stenographers, bookkeepers, store workers, and clerical assistants; to afford a fundamental training in such drill subjects as penmanship, rapid calculation, and business forms that will meet the needs of the student in his capacity as an average citizen; and to be most essential to the man or woman who is to play any important part in the reconstruction and post-bellum periods.

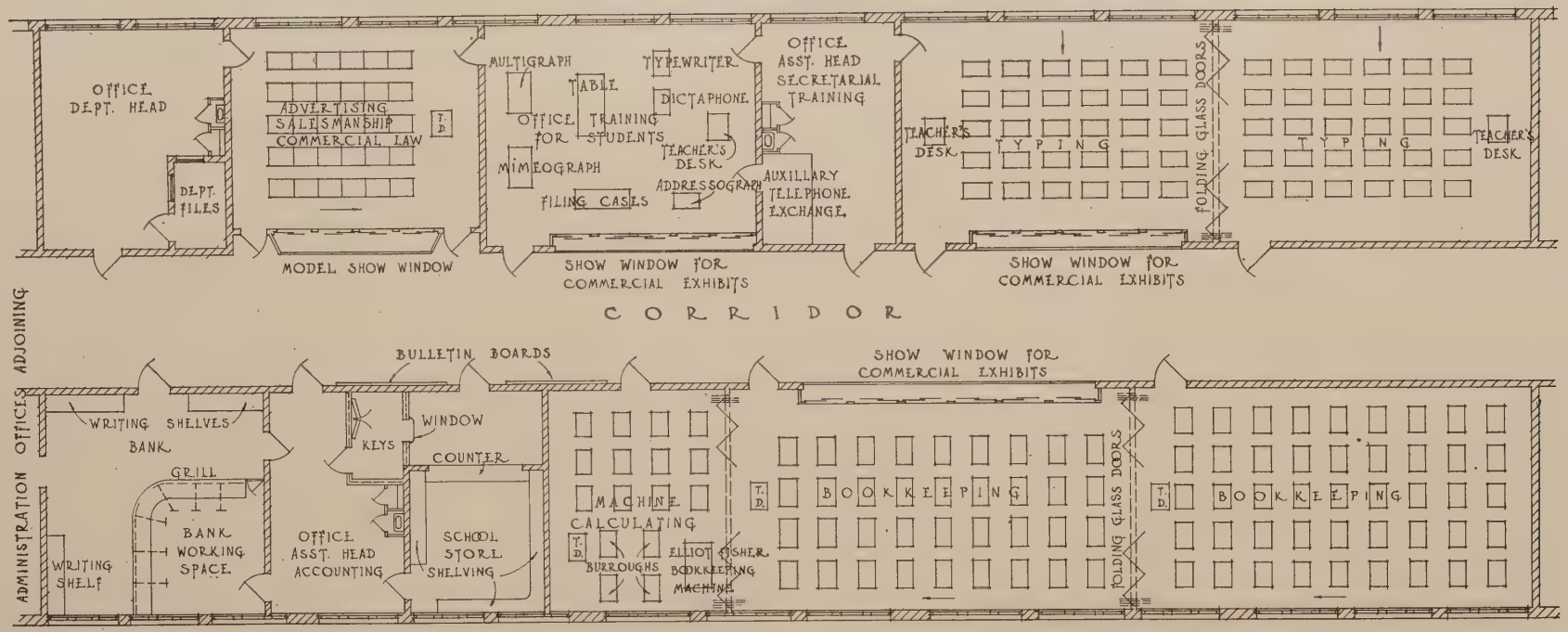
Aside from these primary functions which the commercial department fulfills, no institution can neglect or ignore the many secondary possibilities which may accrue from a progressive business department. Among others may be mentioned the following: stenographic assistance for both administrative officers and instructors, valuable help in dealing with the large number of student activities involving bookkeeping principles, and many other functions which will be considered later in this chapter.

Educational Experimental Laboratories. — The commercial departments of the past have been experimental laboratories, to a considerable extent, in which educational ideals have been practically tried out. A number of accepted and acceptable educational theories have been developed and proved in the commercial departments of the country. This reason should influence the administrative officers both in the selection of the right type of director for this department and the arrangement of classrooms and equipment.

The war has forever changed the position of the schools in this country. Whether we will it or not, the schools must now play a more positive and important part in the immediate life of the community in which they are located. Probably no other department offers as great an opportunity by being so closely linked up with the community life as does the commercial. This again should influence both the personnel and the architecture of the department.

The plan outlined is for a commercial department in a high school having a registration of approximately 2500 students. A well-developed department in a school of this size will require not fewer than 15 instructors. Appropriate modifications of the plan are given for a school with an enrollment of 1200 with 8 commercial instructors and for a school of approximately 300 with a single business teacher. These types will represent in a fairly accurate manner equitable and proportionate distribution of students in the commercial work.

Relation to the School in General. — In the past, it was customary to place the commercial department at the very outskirts of the school plant. In many schools, commercial departments are still housed in temporary buildings, in basements, or in almost any place not desired by some other department of the school. It is not uncommon to find the various classrooms for business subjects scattered in almost as many parts of the plant as there are classes. This unfortunate condition is due, no doubt, to the rather recent development of commercial work in the high schools and to the further fact that administrative officers have not always been quick to appreciate the benefits which might accrue to the entire institution by having this department more fortunately placed.



FIRST FLOOR PLAN • COMMERCIAL DEPARTMENT

SCALE
0' 5' 10' 15' 20' 25'

FIG. 348.

Location in Plant. — If possible, the commercial department should be located very near the center of the plant and in close connection with the administrative offices. This arrangement will make it possible for the commercial department to supplement the regular clerical help in the administrative offices and permit of the development of a workable plan to handle the stenographic and clerical work for department heads and teachers of the entire school. In addition to these advantages, it will be found that many features of the modern high school which are of a quasi-administrative nature, such as the school bank, the bookstore, student body accounts, junior chamber of commerce, and the like, will function more efficiently as an integral part of this department, and should be of necessity centrally located.

Organization of Department. — An efficient organization for a department of 15 teachers calls for a department head, two assistant heads, and 12 regular instructors. The head of the department should have at least one-half of his time available for supervision work in the department and for promotion and investigation work in the community. The assistants should carry full time schedules. They should be assigned, however, to organize and supervise the office training work and the various activities for which this department is held responsible.

Heads of Departments. Duties, etc. — The department head should be held responsible for the general organization of the department and for specific supervision of all subjects of a general commercial nature, such as industrial geography, commercial law, foreign and domestic trade, and the like. It is quite advisable, also, for the department head to be in direct charge of the placement bureau of the school. One assistant should be responsible for the supervision of all work which enters into the training of secretarial assistants, while the other will be in charge of all work leading to bookkeeping and accounting positions. After the office training work and the school activities are well organized, each assistant will find considerable time available which may be used in the supervision of his respective division.

Of course, in certain high schools, it may be found advisable to alter the assignment of duties of the department head and his assistants. The department head may be much better fitted to direct and supervise stenographic training, or the work embraced in the bookkeeping division, than the more general work outlined in the preceding paragraph. This will often happen in schools in which the commercial department has been established for some time and was organized primarily as a competing feature with the local business college. It is well to emphasize the importance, nevertheless, that the department head should be a man of vision, alive to the needs of his community, and in perfect harmony with the rather urgent forces which are, at present, altering our school system.

To secure maximum results, no department head should fail to recognize the desirability of organizing the department in such a manner that the development of initiative on the part of the teachers will be encouraged. In other words, the wise director will endeavor to forestall such criticism as is sometimes made of him by his teachers:

"Only ideas which originate from headquarters are valuable."

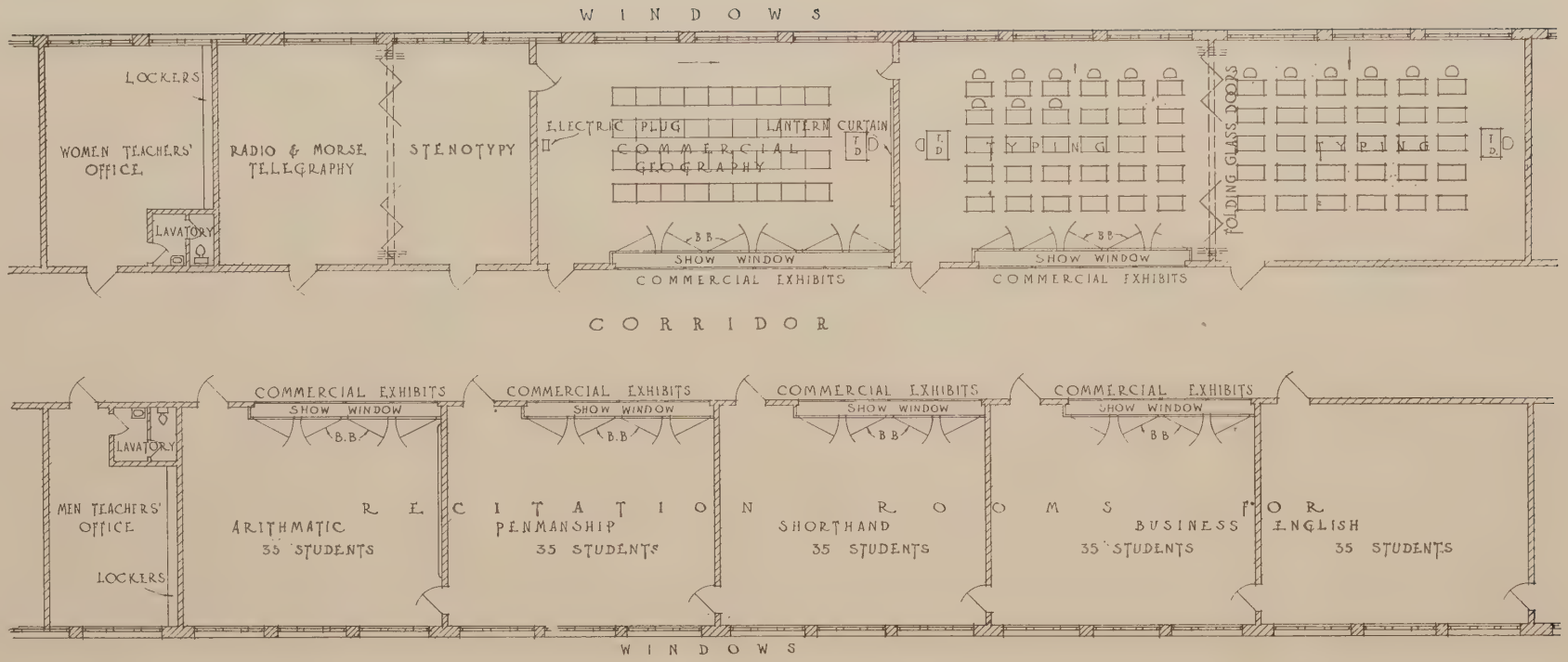
"It is simply my duty to follow directions and say nothing."

So many activities may be correlated with this department that the tactful director will have little difficulty in assigning special problems to each instructor in his corps. In some instances this feature is likely somewhat to affect the architectural arrangement, in others require additional equipment, and in still other cases call for alterations in the daily program. Its advantage, however, in keeping up the *esprit de corps* is well worth the additional effort.

Figures 348 and 349 are floor plans showing a desirable arrangement in the commercial department for a large high school of 2000 or more students.

First Floor Plan. — Following out the ideas already outlined, the first floor plan (see Figure 348) should include the offices of the department head and his assistants, closely connected with the office training and student activities headquarters, the advertising and salesmanship classroom, two typing rooms, two bookkeeping rooms, and a machine calculating room. The plan calls for a rather extensive delegation of student body activities to this department, but by no means a complete assignment. The relative personnel of the commercial department as compared with other departments of the school should be the governing factor in making the alignment of activities by the principal. It is believed, however, that the plan submitted is workable for the average high school.

Department Offices. Filing System. Psychological Tests. — The office of the head of the department is located near the main entrance of the building, and a side door connects it with the advertising and salesmanship room. It is assumed that since advertising and salesmanship are subjects of more recent adoption than the other technical work, the department head will find it desirable to supervise these classes personally. This office will be the headquarters for all records collected from time to time by the department head and his assistants and should be provided with ample filing



SECOND FLOOR PLAN - COMMERCIAL DEPARTMENT

SCALE

0' 5' 10' 15' 20' 25'

FIG. 349.

facilities. Probably no other department in the school affords a better field for the inauguration of psychological testing than does the commercial. The director of experimental psychology will, therefore, welcome an opportunity to coöperate with the commercial teachers in initiating this important work in the school. It is needless to say, however, that such records, while available for the various teachers, should never be open for the inspection of students. Incidentally, it would seem that the ideal place to keep such records for convenience and availability, should be in the offices of the various heads of departments rather than in the main administrative offices of the school.

Placement Bureau. — As Director of the Placement Bureau, the department head should have outside listed telephone connections, as well as connections with the local telephone exchange of the school. Other equipment which should be found in this office includes two flat-top desks, typewriter and stand, a dictating machine, an adding machine, and a half-dozen chairs.

Keys. — Aside from the outside telephone, the equipment of the offices for the assistant heads will be approximately the same as for the department head. In the office of the assistant head for accounting, the filing room gives place to a key room in which keys for every locker and room throughout the building are kept. It will usually be found advantageous to have keys for laboratories or students' desks handled by the heads of the respective departments. Whether keys are kept in the main administrative offices or in the commercial department, will depend upon two factors: first, the amount of clerical help maintained in the administrative department, and second, the policy of the school authorities regarding the use of student help for such activities. High school principals recognize that not one school in a hundred has provided for any plan to handle keys and locker deposits in a safe and satisfactory way. With this plan, however, the responsibility is certain. No one comes in contact with the keys except the assistant head, and the advanced student who is delegated to handle this particular problem.

Auxiliary Telephone Switchboard. — In the office of the assistant head for secretarial training, this space is used to house an auxiliary telephone switchboard which may take over the entire telephone system of the building by special arrangement with the main office. Business men offer more criticisms of high school students because of lack of training in the proper use of the telephone than in almost any other single thing. This arrangement does not throw the entire responsibility of maintaining the exchange continuously on the department, but makes it possible to use this convenience and equipment as long as real educational training may be developed.

School Bank. Functions. — The functions of the school bank are three-fold. It should be the organization whose duty it is to carry on a definite campaign of thrift and saving among the students. It should become the financial center of the school and as such should handle ticket sales for all entertainments, student body fees, etc. It should offer an invaluable office training for a limited number of accounting students who are preparing for positions in banking institutions.

School Bank. Organization and Equipment. — Statutes in many of the states limit the activities of school banks to savings accounts. In states where this restriction is not placed on its activities, a fourth function should be the commercial or checking department, which will be generally patronized by both teachers and students. The school bank should always be authorized by the proper state officials, as well as by the local school authorities. It is almost always affiliated with one of the larger banking institutions of the city, and the close relations which are thus formed will work to a better mutual understanding of the problems of both school and bank.

Two entrances to the lobby of the bank are provided. This plan will make the handling of a large number of students, as *e.g.*, the payment of student body dues, a relatively simple problem by routing them in one door and out the other. Ample writing space should be provided in the lobby. An iron grill or glass partition isolates the section reserved for the bank officials. The plan provides for an entrance to this space through the office of the assistant head who is in direct charge of this activity.

Equipment should include counter space with cash drawers and cabinets for supplies underneath, a Burroughs adding machine, typewriter, a flat-top desk, check protector, and a filing unit for signature, ledger, and statement cards.

School Store. Supplies. — As a matter of convenience and economy, most schools will find it desirable to handle the books and supplies required by students. Uniform prices and standardized supplies can be assured in this way with little difficulty. By a careful arrangement of the program it will not be found necessary to keep the store open for more than two periods daily after the first week of the term. The school store should handle all stationery supplies furnished by the board of education for departments and teachers of the school as well. Such supplies should be delivered on requisitions only. It will prove a relatively simple problem for the principal or department head to determine exactly what has been the disposition of supplies at

BIRMINGHAM REFERENCE LIBRARY

the end of the school year. The school store will, therefore, not only make standardization of prices and materials feasible for the students, but furnish, as well, the data which may be used in formulating rules to govern a reasonable use of supplies by the teachers.

The equipment should include a counter with cabinets underneath, together with shelving on three sides of the room. A desk and filing case should be located in the center of the room. A cash register should be used to record all sales.

It may be thought that the room is too small to handle supplies for a school of 2500 students. However, if the room is used merely as the distributing point for supplies and a storeroom for additional material kept in the basement, it will be found entirely satisfactory.

Advertising and Salesmanship. Continuation Courses. — The desirability of offering strong courses in advertising and salesmanship can be readily appreciated when it is realized that many more students will follow some line of selling than will go into stenographic or bookkeeping positions. Heretofore, little attention has been given these important subjects in the high school. It is probably true that the commercial department will always be concerned more with secretarial training than with selling. This is true because many salespeople enter this work from the grade schools rather than from the high school. Nevertheless, the tendency of modern education is to keep the boy and girl at their studies as long as possible. Consequently, school systems are extending their training to include work which has been given, heretofore, chiefly in the trade itself. If the school building is located near the business district — particularly the retail section — a plan of cooperation usually can be worked out with department store managers for the loan of material for the study of textiles and window dressing; for the training of employees in continuation classes on the employers' time; and for a systematic placement and follow-up system of all students who enter this work.

Oakland Technical Continuation High School

Job No. *264* Date, *Jan. 10, 1919*

Miss (A)

Please furnish stenographic assistance as follows:

Amount	Items	Rate	Value
	Multigraph copies as per sample		
25	Line composition	40	$1.00
500	Sheets medium bond		2.00
	Printing		3.00
Cost of material, *$2.00.* Labor, *$4.00.* Total .			6.00

Teacher *Mr. (B)*, Department *English.*

Fig. 350. — Order Blank for Stenographic Book.

General and Specialty Salesmanship. — Aside from this course in retail selling, which may be labeled "department store selling," "merchandising," or some other appropriate term, a class in business psychology, which may be called, "general and specialty salesmanship," should be offered as a free elective. This work will prove most beneficial as a part of any student's general training. A suggestion should be offered, perhaps, that a rather full outline of this course ought to be presented to the school authorities for indorsement, in order that it may not be built on selling tricks and questionable business practices.

Model Shop Window. — The room is located next to the head of the department in order that this work may receive his personal supervision. A platform should be placed at the front of the room for staging demonstration sales. A panel of burlap should extend around the room, or some other provision be made for the suitable display of typical advertising material. A model shop window should be constructed in the wall next to the corridor. The class in window dressing will find little difficulty in securing the coöperation of merchants in the vicinity in arranging typical displays, while in the case of "drives" for the Red Cross, or other charitable or patriotic projects, most appropriate use can be made of the window in staging a novel and effective appeal to the entire student body. The location of this room near the center of the plant will greatly enhance its advertising value. Aside from the occasional use which can be made of the window to aid in promoting school activities, its location on the main corridor is fortunate, because the approval or lack of approval of displays by the students who pass the window offers a most desirable incentive to the class in window dressing.

Junior Chamber of Commerce. — This room may be used quite appropriately by the junior chamber of commerce as its official headquarters. In fact, this organization should be solicited to provide material for displays covering the products of the section.

Office Training. — Office training is here intended to include the opportunities afforded the student to do actual stenographic or secretarial work. This is a most important part of his education and provision should be made accordingly. Aside from the advantages which the student himself derives, office training affords an excellent opportunity to aid materially almost every department and teacher of the entire school. In fact, it is obvious that every teacher in the modern high school has considerable stenographic work which must be done. He must either do it himself or have stenographic assistance at his disposal. Economy and efficiency should show the fallacy of requiring teachers to

FIG. 351. — BOOKKEEPING DESKS.

do any considerable amount of clerical work themselves. The director for secretarial training should develop a course which while being of practical assistance to the school in general, is truly progressive and educational for the students themselves.

Job Records. Student Secretaries. — All work handled by office training students must be approved by the instructors and a definite record kept, which shows the nature, amount, and commercial value of each job, the name of the party for whom the work was done, and the estimated cost of materials used. Figure 350 shows a satisfactory job card. By direction of the instructor, student secretaries may be appointed to assist teachers or school officials when the work warrants it. The work of student secretaries must be carefully supervised in order that it may be of real educational value. The instructor may find it advisable to outline briefly the work which should be expected of these students.

A plan which has worked satisfactorily in a number of schools is to install dictating machines in various parts of the school plant for use of teachers and officials. The "filled" records are sent to the office training room for transcription. This plan permits of stenographic assistance at all hours of the day or night.

Principals' Secretaries. — Advanced stenographic students from the various high schools of Oakland, California, are appointed by the superintendent of schools to positions as principals' secretaries in the larger grade schools of the city. These students receive both school credit and a nominal compensation for their services.

The room should be equipped with a power mimeograph, multigraph, addressograph, dictaphones, and ample filing cases. The location of the telephone exchange in the adjoining room makes this switchboard a part of the office training equipment.

Bookkeeping. Farm Accounting. Household Accounts. — Bookkeeping should always form an important part of the commercial training in any high school. The location of the school should determine to a large extent the particular applications of bookkeeping principles which will be made in the more advanced work. In

Mr. John J. Donovan, Architect.

FIG. 352. — BOOKKEEPING DEPARTMENT, OAKLAND TECHNICAL HIGH SCHOOL, OAKLAND, CALIFORNIA.

other words, farm bookkeeping should form a considerable part of the course in rural high schools. In the same way, departments enrolling a large number of girls should offer applications of the principles of bookkeeping in household accounts. Nothing develops interest and enthusiasm as rapidly as a realization that the school work is directly applicable to the problems of life. It should be perfectly obvious that such direct applications to everyday problems will not only interest the students, but will create a favorable attitude of coöperation on the part of the parents as well.

Bookkeeping. Office Practice. — No provision has been made for special office practice as developed by a number of authors of bookkeeping texts. It is believed that the management of the student activities outlined will prove an even more valuable training than the made-to-order work to which reference is made. If, however, no arrangement is made to assign student activities to the commercial department, then it should prove most valuable to have provision made for this type of office practice.

Bookkeeping Desks. — The equipment should include the regular teacher's desk, forty-five students' desks, ample blackboard space, etc. The bookkeeping desk suggested (see Figure 351) offers sufficient space for books and forms, provides for two inkwells, and affords drawer accommodations for the temporary disposal of superfluous books and supplies not needed in this particular recitation. The question may be raised, should provision be made for the accommodation of bookkeeping outfits of the students in the desk itself. In determining the relative value of purchasing a desk with ample drawer space to accommodate all the students who may use the desk during the day (see Figure 352), the following factors should enter into the decision:

1. The maximum use to which the plant will be placed.
2. The relative floor space of the two desks.
3. The relative cost of the desks.
4. The relative convenience to the student in being able to store his supplies in the desk or being obliged to carry supplies with him to and from his locker.

Maximum Use of the Plant. Continuation School. Evening School. — At the present time, many schools are maintaining classes for from 10 to 12 hours daily, while not a few operate for longer periods. Oakland, California, Technical High School opens for recitation in the regular day school at 7 : 10 A.M. Classes continue until 4 P.M. However, at 2 : 30 the continuation school opens a large number of adult classes in rooms not required by the day school for the remainder of the afternoon. These classes regularly continue until 4 : 40. At 5 o'clock, supper classes begin which extend to the opening of the evening school at 7 : 15. While a majority of the evening school classes close at 9 : 30, a number continue until 10 : 30. In other words, this school operates classes for more than 15 of the 24 hours. For 12 hours daily it operates to its capacity. In such a school, provision must be made to handle at least 14 forty-minute periods per day. Estimating 2 periods daily for each bookkeeping student, accommodation must be made for at least 7 students per desk.

Figure 352 shows a desk of seven drawers, one drawer of which, if not required as a locker, may be used to store temporarily the extra books of the student while reciting. This desk requires 50 per cent more floor space than the first desk shown. With the first desk, it will be easily possible to seat 45 students in the bookkeeping room. With the second desk, the room will be crowded for more than 30 students.

It is believed that the live teacher in this subject can readily organize his work to handle the forty-five students assigned to each room.

The first cost of the larger desk is nearly 50 per cent higher than the one recommended, and the operating cost per pupil is increased accordingly.

Finally, it is believed that ample space is provided in the regular students' lockers to accommodate all bookkeeping outfits and supplies, and that the carrying of such material to and from lockers will not prove unduly burdensome.

Extreme care should be exercised in locating the bookkeeping rooms in a most favorable position with reference to the light. The great amount of writing and ruling required in this subject demands ample and well regulated lighting facilities. The window glass area should be equivalent to not less than 20 per cent of the floor area of the room.

Typing. — The writer judges no thesis is necessary to convince school men of the importance of typing for commercial students, and even of the great desirability of throwing the subject open as a free elective to students of the entire school. The world's business to-day speaks in terms of typewritten characters. Every man and woman in business or profession uses the typewriter. The only question involved is whether the expenditure of an hour a day for a year is too great an outlay for the time and energy saved in after life. Without question every high school boy and girl should operate the typewriter better than " indifferently well."

If one side of the plant fronts on a noisy street, it would be well to locate the typing rooms there, since outside disturbances will cause less inconvenience in this work than for, say, classes in shorthand.

Typing Desks. — Two different desks are again shown. (Figures 353 and 354.) Exactly the same problem is involved as in the bookkeeping desk. There is no question that the smaller desk is more economical. If the smaller desk is selected, additional desk keys are not required, and the amount of details is correspondingly lessened. Typewriter desks should have three drawers which may be used for covers, cleaning tools, and cloths. Typewriter companies advise against the bolting of machines to the desks. The ideal arrangement permits of the removal of the machine for adjustment or for cleaning the desk.

FIG. 353. — TYPEWRITER DESK.

St. Louis Typing Room. — Figure 355 is a view in the typing room of the Grover Cleveland High School, St. Louis, Mo. A special type of drop-head desk is used. It is doubtful if the additional expense of this desk is really justified.

Mr. John J. Donovan, Architect.

FIG. 354. — TYPING ROOM, OAKLAND TECHNICAL HIGH SCHOOL, OAKLAND, CALIFORNIA.

Typewriters, Care and Repair. — A word should be said about the extreme wear and tear to which a typewriter in the modern large school is subjected. With from four to ten different individuals using it daily, practically all of whom are novices, the strain on the machine, even under careful supervision, is many times what it would be in the average office. It is advisable to have a repair man visit the department regularly to handle difficulties which are beyond the average student. It sometimes happens that a boy in the industrial department may be assigned to handle the repair work as a definite part of his shop course. Unless closely supervised it is doubtful if this plan is advisable.

Calculating Appliances. — Quite recently the call for calculating and bookkeeping machine operators has become so great that it seems probable that all large schools in the future will offer instruction on these machines. In the plan shown, a medium sized room, next to the bookkeeping classes, is left for this work. Classes in advanced bookkeeping will find machines conveniently located for their use. It will be advisable to have only a limited number of students become familiar with the operation of the bookkeeping machines. A survey should be made of business houses in the community to determine the probable demand for trained operators. Regular class work should be given on the comptometers and other calculating machines.

Equipment in the calculating appliance room should include comptometers, non-listing Burroughs, an Elliott-Fisher Bookkeeping Machine, a Burroughs Statement Machine, Marchant Calculators, and other types now in common commercial usage. Where no special pedestal is furnished with the machine, as in the case of the Elliott-Fisher and the Burroughs Statement machine, the desk used for typing is recommended.

Second Floor Plan. — The second floor plan (see Figure 349), of the Commercial Department includes: offices for men and women teachers, two small-sized rooms which may be used for radio, Morse telegraphy, stenotypy, or for other small or experimental classes, five recitation rooms, two typing rooms and a commercial geography room. Built-in commercial exhibit cases are arranged throughout the corridors as in the first floor plan. Folding glass doors are located between the

Mr. Wm. B. Ittner, Architect.

Fig. 355. — Typing Room, Grover Cleveland High School, St. Louis, Missouri.

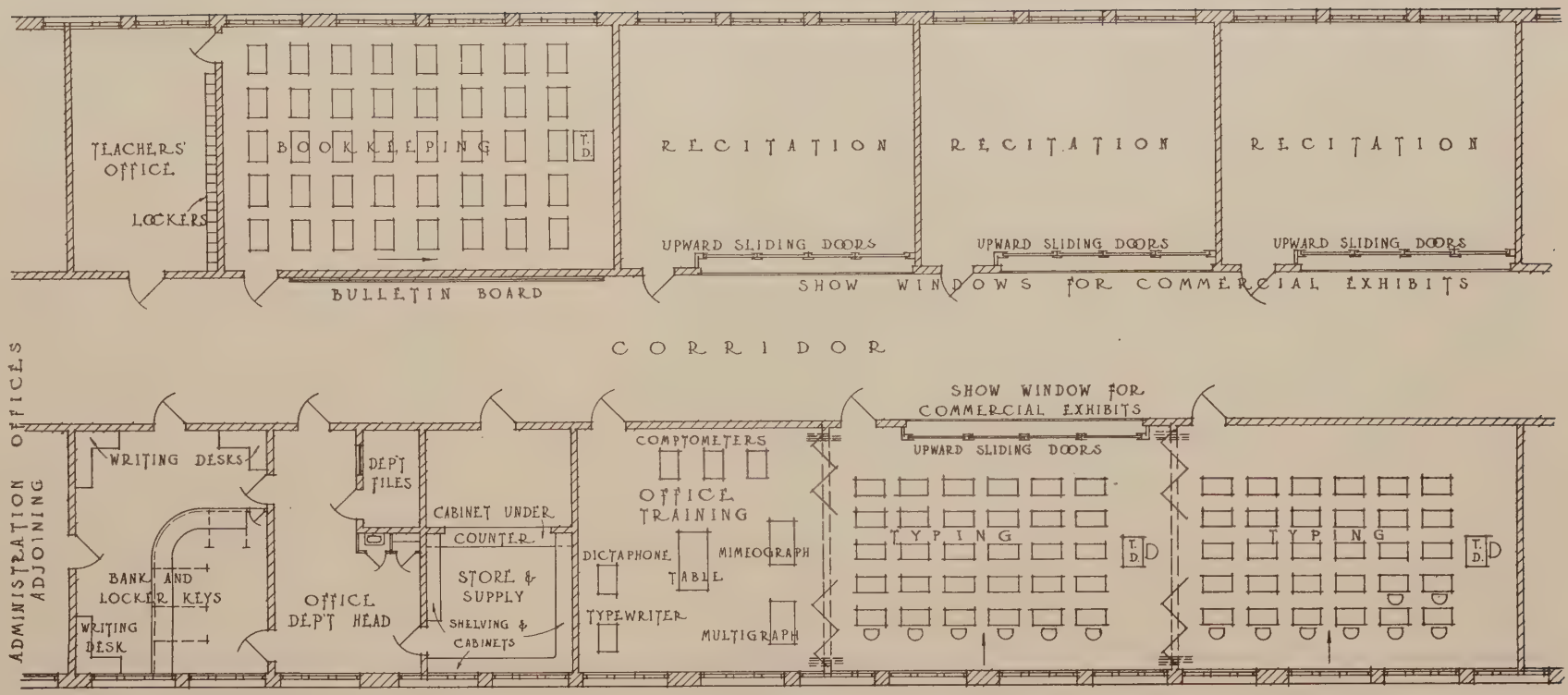
two small rooms and the two typing rooms. This arrangement makes it possible to utilize the small rooms for standard sized classes if necessary. It also makes it possible for one teacher to supervise both typing rooms during practice typing period.

Teachers' Offices. — The assignment of these offices will depend upon the relative number of men and women instructors in the department. Under ideal conditions, the number should be about equal. A survey of a large number of departments, however, shows that there are approximately 60 women instructors to every 40 men instructors of commercial subjects. If the plant is used to its maximum capacity, it becomes absolutely impossible for the teacher to meet pupils in her classroom at the close of the recitation. Some other place must be provided for this purpose. An office with a sufficient number of desks to accommodate the teachers will prove reasonably satisfactory. The trend in the educational world seems to lead toward a longer school day in the school plant itself. The actual teaching time may not be extended, but a number of office periods will be provided to afford opportunity for the counseling of students by class advisers. These periods will be utilized also in completing the necessary laboratory and preparatory work incident to the development of a successful recitation. Necessary locker facilities are provided in each office.

Stenotypy, Radio, etc. — If one of the functions of the commercial department is to provide an educational experiment ground, then provision must be made for satisfactory "laboratories" in which ideas may be thoroughly tested. If after sufficient trial, a project seems not adapted to meet the needs of a particular community, it can be readily discontinued and some other "possibility" tried out. The plan whereby these rooms may be converted into regular classrooms with little or no difficulty aside from the rearrangement of equipment, does not involve either a great expense or an economic risk.

The arrangement in the typing rooms on the second floor is exactly the same as that of the first floor.

Typewriters' Selection. — A word might be added regarding the selection of makes of typewriters and arrangement in the rooms. If possible a survey should be made of typical business institutions of the community. The proportion of typewriters purchased



FLOOR PLAN OF COMMERCIAL DEPARTMENT

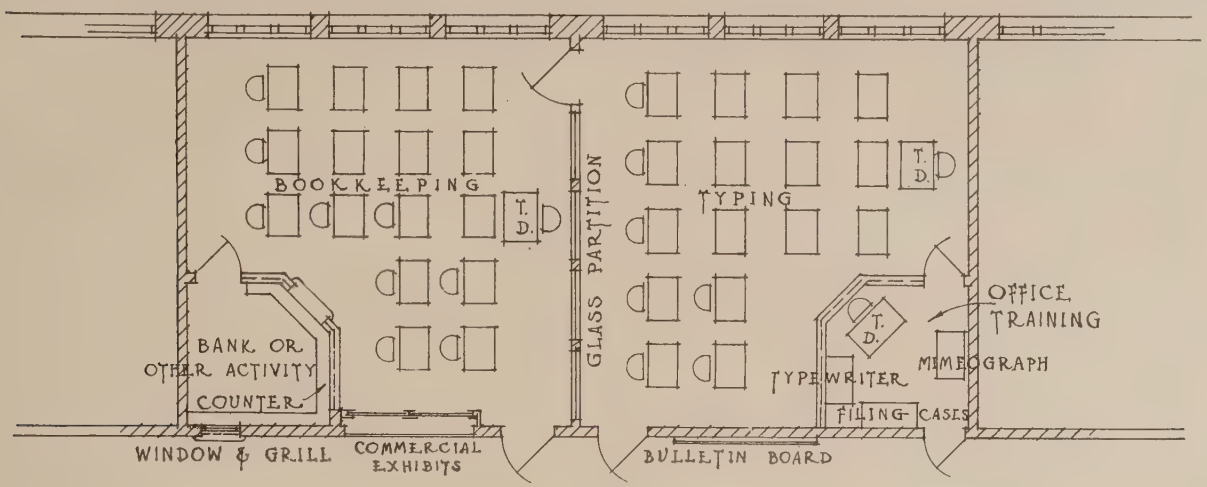
EIGHT TEACHERS

HIGH SCHOOL ENROLLMENT OF FROM 1000 TO 1500 STUDENTS

SCALE

0' 5' 10' 15' 20' 25'

FIG. 356.



FLOOR PLAN OF COMMERCIAL DEPARTMENT

ONE TEACHER
SCHOOL UNDER 500 STUDENTS

SCALE
0' 5' 10' 15'

FIG. 357.

should be about the same as the survey shows in use in the community. The arrangement of machines in all typing rooms should be identical in order that classrooms may be interchangeable.

Commercial Geography. — The geography of industry should be included in any well-balanced commercial course. Eventually this subject should develop for the student a set of principles which will assist him in judging the relative future possibilities of both industries and communities. By this suggestion the writer does not have in mind the impossible proposition of turning out industrial experts or municipal planning specialists. He simply recognizes the fact that one of the most potent causes of failure is a poor selection for the location of a business. Failure may happen either because the business is not adapted to the community in which it is located, or the community may be overstocked with that particular line.

Laboratory Material. — If the course is a year in length, one half of the time should be spent in a study of local industries, while the other half should be given to a consideration of the world's commerce. Since text books can furnish but a small amount of the data required for such a course, it will be absolutely important to secure a large amount of original material from the industries of the section, from the publicity organizations, and from state, federal, or municipal authorities. It is recognized that some of the material furnished will be more or less colored by local prejudices. This point is rather in its favor, however, since the student in making his deductions must exercise judgment in the selection of data which he will use. Most of the material is put out in an interesting and attractive form. The students themselves should be encouraged to collect the material. This again will have a tendency to link the schools up more closely with the business and industrial life of the community.

A course in Foreign and Domestic Trade may be given to seniors or continuation school students in this same room.

Filing Equipment. — If original material is to be collected, it must be classified and filed in such a manner as to make it available for constant use in the classroom. Cabinets and filing cases should be provided for this purpose. Next to visiting a plant and actually seeing the various processes in the manufacture of raw material into the finished product, is to follow the same processes by means of appropriately selected lantern slides. Provision should be made, therefore, for a balopticon, which handles both opaque projections and lantern slides. A curtain should be installed at the front of the room and the window casings constructed in such manner that the room may be easily darkened. Ordinary desks which will permit of map drawing should be installed.

Commercial Exhibits. — Exhibits which show processes in the manufacture of industrial products should

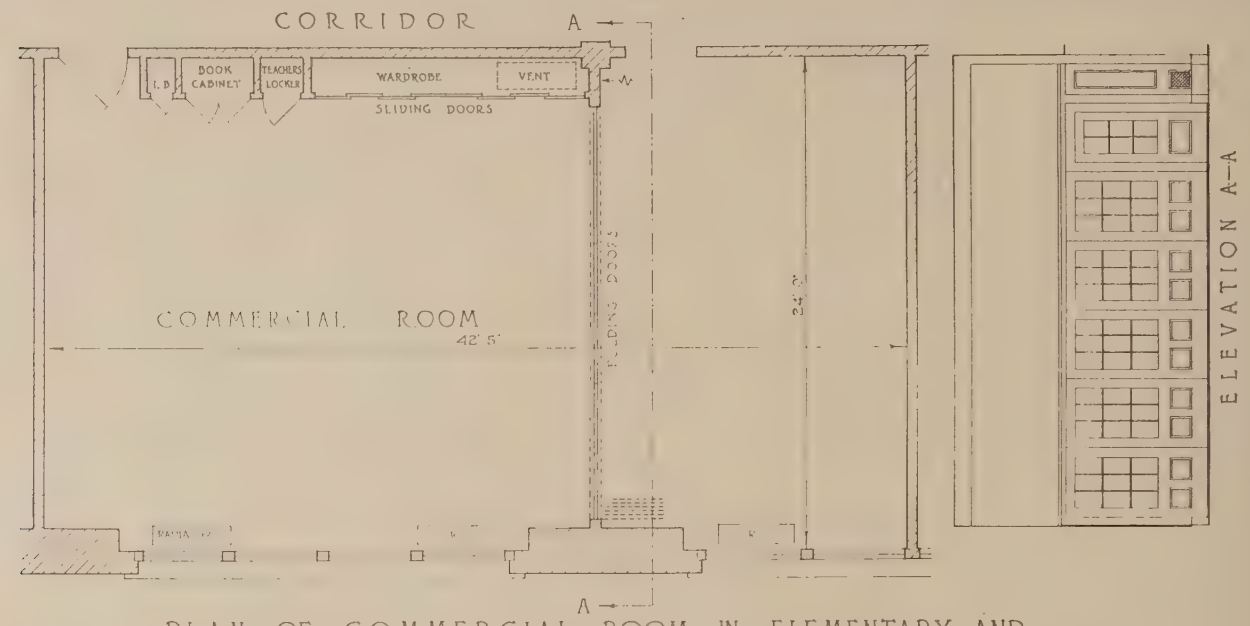


Fig. 358.

be collected for study by the students in commercial geography. It will be found that no more fascinating assignment can be made to average high school students than to secure appropriate collections of such materials. Hundreds of excellent exhibits, such as silk, cotton, rubber, oil, and the like, may be readily secured from industrial concerns. The location of the commercial exhibit cases in the corridors makes all of these exhibits available for the entire school.

Recitation Rooms. — The plan calls for five recitation rooms. Each room should be furnished with 35 desks. In making the selection of desks it should be kept in mind that considerable writing will be required of the students using these rooms. Among other classes which will be assigned are the following: penmanship, arithmetic, rapid calculation, business English, shorthand, commercial correspondence, and other subjects requiring no special equipment. It is assumed that the subjects named are so well recognized as forming a part of a symmetrical commercial course, that individual treatment is unnecessary.

Modifications of Plan. — Figure 356 shows a modification of the plan suitable for a medium-sized high school with from 7 to 9 commercial teachers. The office of the department head is so placed that he can supervise the school activities. Approximately, one-half as much space is allowed for typing and bookkeeping as in the larger plan. Three recitation rooms should accommodate work offered in advertising, salesmanship, commercial law, industrial geography, and other subjects requiring no special equipment. The distinctive features of the larger plan are retained in this modified one. If the location of the school seems to warrant the additional expense, one of the recitation rooms may be especially arranged to handle advertising, salesmanship, and industrial geography. This may readily be done by combining the features of these two rooms as shown in the larger plan.

Figure 357 is a modification for a one teacher department. The essential features here are to retain as many of the good points of the more complex arrangement as possible, and yet have all the department so planned that it may be easily supervised by one instructor. The two small offices permit of practical application of both the stenographic and bookkeeping office training. If it is planned to operate very small classes throughout the entire day, the typing room may be made smaller. All partitions both between the rooms and inclosing the offices should be made of glass.

Standardized Plans, New York City. — Figure 358 shows a plan for a small department in an elementary and intermediate school as worked out by Mr. C. B. J. Snyder, Architect for the New York City Board of Education. Folding glass doors between the rooms permit of the supervision of both classes by one instructor. The wardrobe takes the place of student's lockers.

CHAPTER XXI

THE DRAWING DEPARTMENT

By Ralph C. Sisson, B.S., M.A., *Instructor in Drawing, Oakland Technical High School, Oakland, California*

The Drawing Department.
Elementary and Intermediate Schools. — Freehand Drawing. Mechanical Drawing. The Danger of Beginning Too Early.
The High School. — The Trend of High School Education. General Considerations. Light. Night Lighting. Wall Covering.
The Freehand Department. — The Courses. The Equipment.
The Mechanical Drawing Department. — The Courses. The Geometrical Drawing Room. The Trade Drawing Room. The Technical Drawing Room.
Some Rooms in the High School. — Library, Lecture Room, and Study. Offices. Store and Blue Print Rooms. Dark Room.
Summary.

The Drawing Department. — Drawing is the one universal means of expression. An object may be variously labeled in the written or spoken language of different peoples, but the same object, properly drawn, finds recognition in any land. This is true, not only of pictorial drawing, but also of the working drawings which must precede the making of any article or the building of any structure.

In this country, with its intense development of constructive activities, the need for general instruction in the principles of drawing is becoming apparent. In the realm of fine art America is just beginning to find a place, and the rapidity of her development in that direction depends upon the educated appreciation of the people. Advertising has risen to a place of supreme importance in the business world. One of the most important elements in the advertising organization is commercial art, a field of endeavor that offers rich reward to those who enter it. It calls for a study of drawing, composition, and color in addition to methods of reproduction and psychology. To the practical-minded man, it represents a kind of art that pays. In the rush of manufacturing, into which this country is about to enter as a leading nation, mechanical engineers and draftsmen will be in great demand. It is these men who will design the machinery and products involved. The mechanic must have a knowledge of working drawings to enable him to lay out and perform his work properly. What is true of manufacturing is also true of building. Every artisan as well as every architect and engineer must be able to understand and work from drawings. Even the clients should have an understanding of drawing to enable them to know that they are getting what they want.

Thus it is seen that almost no one escapes the need of a study of the principles of drawing. For this reason, it is most unfortunate that mechanical drawing should be the aristocrat in the curriculum of our public schools. The cost of good instruments is so great as to be beyond the means of many students, while the cheaper grades are apt to prove more of a handicap than a help. In spite of the difficulties, school ownership of instruments seems to be the only solution of the expense problem. If the schools are able and willing to supply shop tools and musical instruments, why not mechanical drawing equipment as well?

Two schemes have been tried with success. One requires a deposit covering the cost of the instruments. The student uses the set during the term, and upon returning it, receives his deposit minus deductions for breakage, etc. In the second scheme, the student signs for a set each day, returning it at the end of his period. A smaller deposit is required, as the instruments on no occasion leave the room. This scheme requires only one third to one quarter as many sets as the first, for each set may be used by a number of students. Again, the instruments will be kept in better condition and last longer because of the inspection at the end of each period. The disadvantages of the scheme are that a tool room for storage of instruments is necessary, and the instructor or a student attendant must be in charge at the beginning and end of each period to give out and check in sets of instruments. The student inspects the instruments he receives to see that they are in good condition, and the attendant inspects those returned. Of course, the time thus taken is lost from the drawing period, and six minutes a day means a loss of ten hours in two hundred days for each student. Students who can afford it should

be encouraged to get their own instruments, but some provision should be made for those who are not so fortunate.

Elementary and Intermediate Schools. *Freehand Drawing.* — The freehand drawing offered in the elementary schools is of a very informal nature. In fact, the subject has been looked upon with favor because it offered an opportunity for relaxation from the strain of more formal academic subjects. The subject matter is chosen with the purpose of interesting the student. Principles of perspective developed in the drawing of cubes, cylinders, and prisms would not hold the interest of young minds; so furniture, model houses, etc., involving the same principles, have been substituted. A high degree of accuracy cannot be expected from the younger students, and consequently the less exacting natural forms, such as flowers, find favor. All children are fond of color and take delight in its use. This element of interest is recognized and used very extensively.

Since the teaching of elementary school drawing is not very formal, special drawing rooms, while desirable, are not absolutely necessary. In fact, in the crowding that comes with the growth of every school, it is the tendency to convert all special rooms not working full time into classrooms. It is probably better to arrange a classroom so that it can be used for drawing, rather than to lay out a drawing room which, when the conversion comes, may be neither a good drawing room nor a satisfactory classroom. Such a classroom would answer all requirements for elementary drawing, including even the lighting, since very little study of light and shade is carried on.

Mechanical Drawing. — Mechanical drawing in the elementary school has, very properly, been limited to pencil drawings, mostly of the simple pieces of furniture, etc., which are made in the manual training shops. This drawing is usually done under the supervision of the manual training instructor. The equipment necessary in addition to that of the manual training room consists simply of a small drawing board, T square, and triangles. The manual training tables serve nicely as drawing desks, and additional lockers are unnecessary.

The Danger of Beginning Too Early. — There is a very natural tendency to reach back and offer drawing at the earliest possible time. This tendency is the result of the attempt to cover a maximum amount of ground in the period given for the education of the average student. The idea is certainly a praiseworthy one, but the educator's zeal in that direction should always be tempered by a realization of the danger of introducing a subject before the child has reached a maturity sufficient to deal with it. While the danger is present in both the freehand and mechanical drawing, it is more evident in the latter. The mechanical drawing is extremely popular with the students, and it is essential to any serious work in the shops. The result is that a subject formerly offered in the universities and in the fourth year of the high schools is now offered in the second year of the high schools, and some ambitious manual training teachers would introduce the same subject in the seventh and eighth grades of the grammar school. It is obvious that a grammar school student cannot master the principles of geometry necessary in geometrical drawing. Again, the adolescent child is growing rapidly, and his muscular action is almost certain to be erratic; work with instruments requiring precision and the use of ink would prove to be discouraging and useless. The time would be wasted, and standards which would be difficult to raise materially later, would be established. The student is not ready for geometrical drawing with ink until his second year in high school. Until that time, his drawing should be with pencil and should consist of the simple working designs used in his shop work.

The High School. *The Trend of High School Education.* — The tendency in recent years has been strongly in the direction of vocational education. The purely academic school of yesterday is felt to cover only a portion of the field of secondary education; in consequence technical, vocational, and trade schools and departments are being organized and developed to cover the remainder. The combination of the vocational or technical school with the academic in one institution should prove one of the greatest forces conceivable working toward a true democracy. There are a great many difficulties to be met with, and it is probably to the smaller communities where the single institution is absolutely necessary that we must look for the successful solution of this problem.

Among the departments most directly affected by this new development is the drawing department. But a few short years ago, the drawing department of the largest high school consisted of only one or two freehand and mechanical drawing rooms. Generally the freehand teachers taught sewing, and the mechanical drawing teacher filled out his program with manual training, mathematics or science. To-day, in the freehand department, courses are offered in commercial art, show-card writing, art metal work, pottery making, bookbinding, interior decoration, costume design, etc. The student completing any of these courses has no difficulty in finding permanent or part time employment with good pay in the local business houses. All the posters advertising school activities, such as plays and liberty loan drives, are made in the department, as are illustrations and decorations of the school papers and magazines which may be printed in the school shops.

In the mechanical drawing department, the student

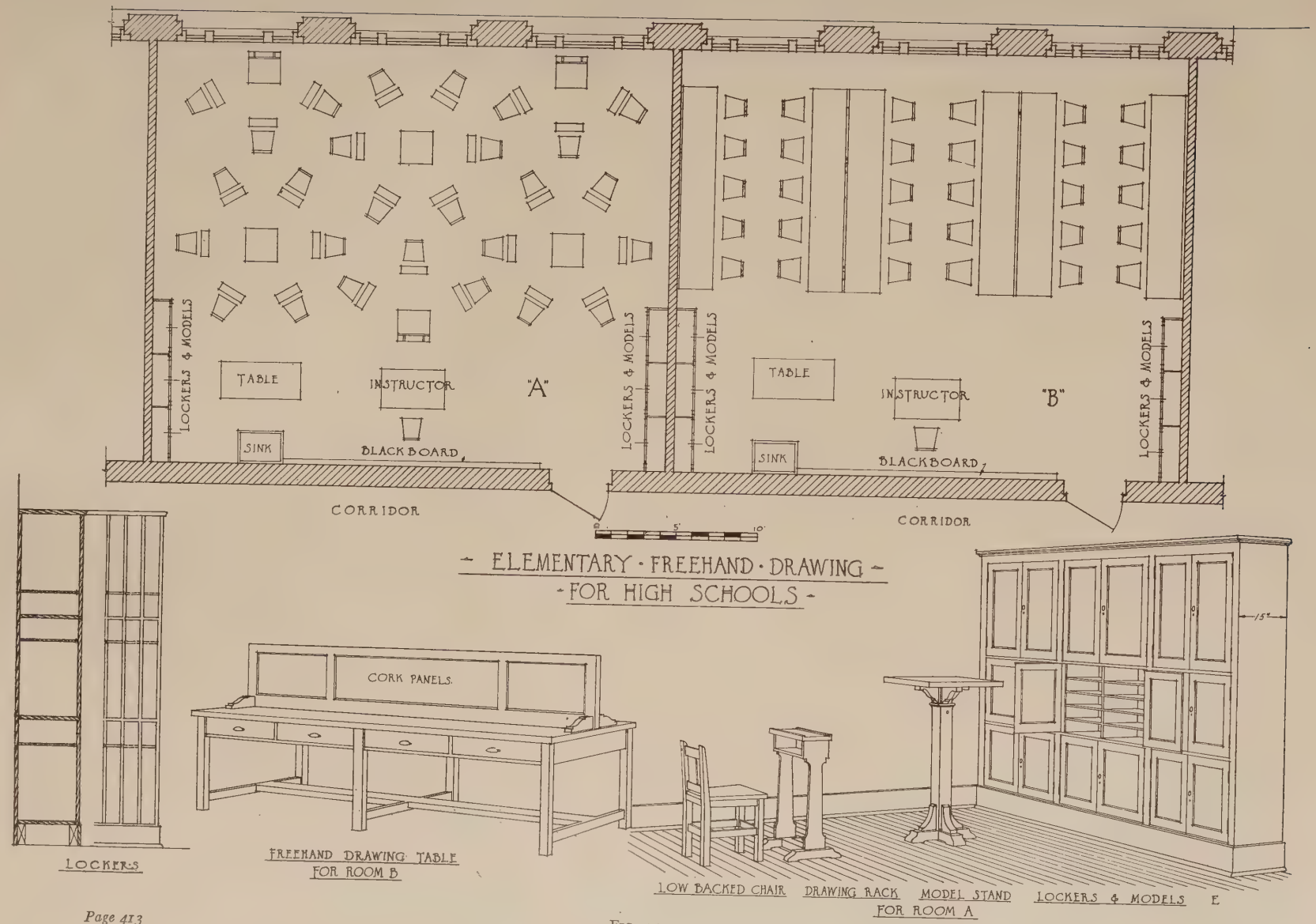
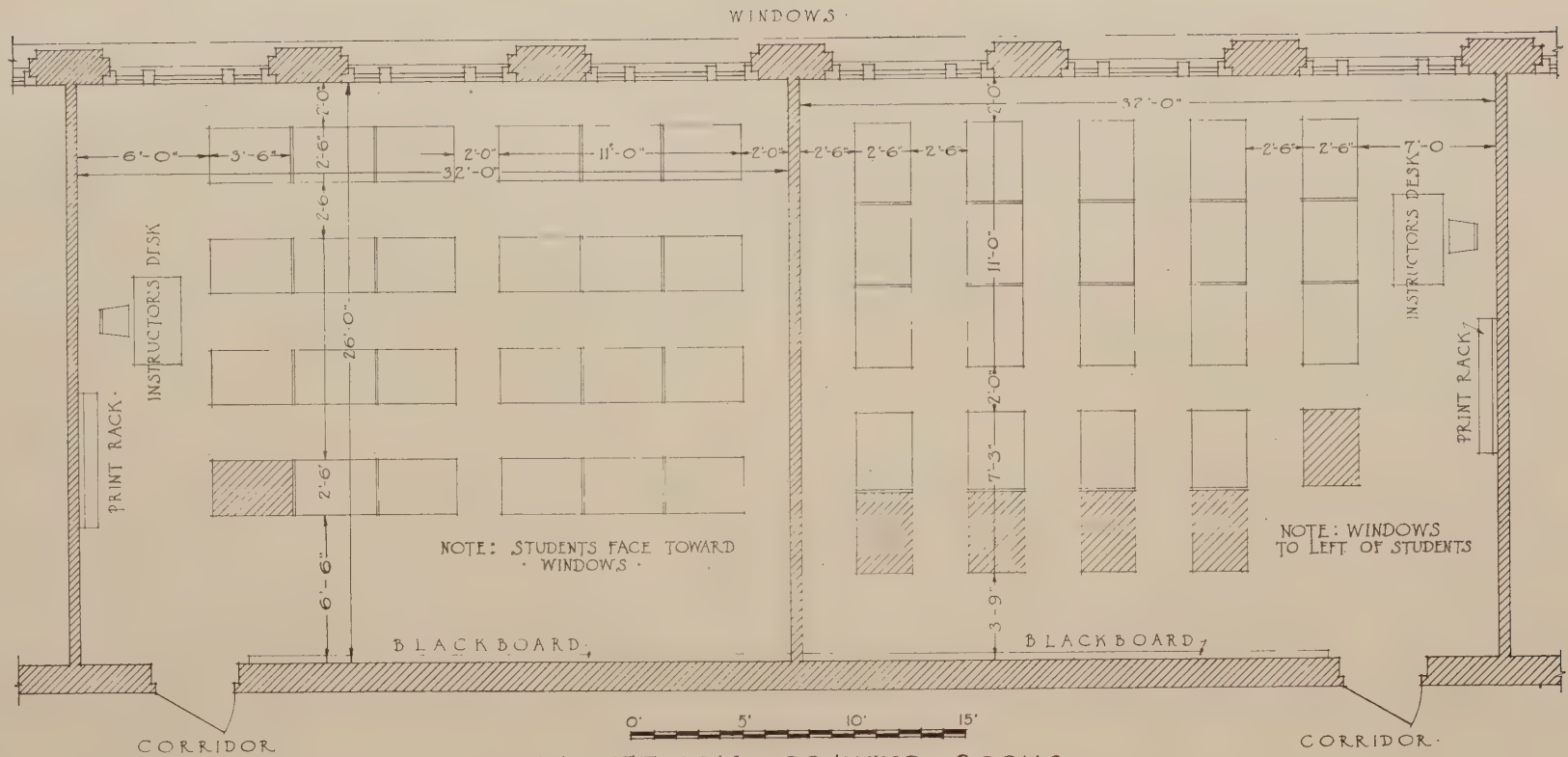
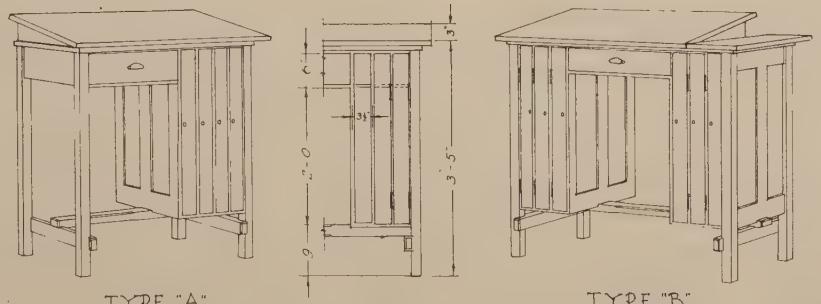

LOCKERS & MODELS
TABLE
INSTRUCTOR
"A"
SINK
BLACKBOARD
CORRIDOR
LOCKERS & MODELS
LOCKERS & MODELS
TABLE
INSTRUCTOR
"B"
SINK
BLACKBOARD
LOCKERS & MODELS
CORRIDOR
5'
0
- ELEMENTARY · FREEHAND · DRAWING -
- FOR HIGH SCHOOLS -
CORK PANELS.
15"
LOCKERS
FREEHAND DRAWING TABLE FOR ROOM B
LOW BACKED CHAIR
DRAWING RACK
MODEL STAND
FOR ROOM A
LOCKERS & MODELS
E

FIG. 359.

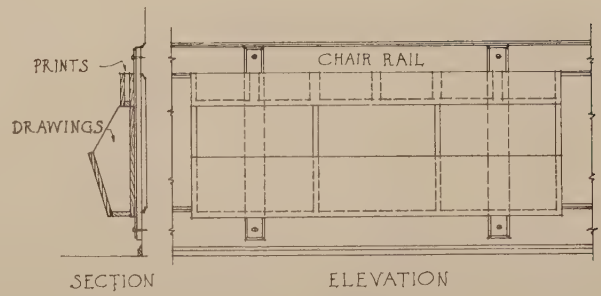


GEOMETRICAL DRAWING ROOMS FOR HIGH SCHOOLS



TYPE "A" TYPE "B"

MECHANICAL DRAWING DESKS



BLUE PRINT & DRAWING RACK

FIG. 360.

may now add to his course in geometrical drawing very complete and well-organized courses in mechanical, architectural, or ship drafting, mapping, etc., as he may elect. These courses are, generally speaking, based upon the apprentice system as established in the various trades and professions. Local conditions and demands for labor will determine largely what branches of advanced mechanical drawing will be offered. The advantages to the student consist of a properly organized and complete course, increased personal supervision, and the opportunity for related technical studies.

This development of the drawing department along vocational lines fills a long-felt need. Not only does it reduce the period of apprenticeship for the student whose schooling must stop with the high school, but it provides a proper foundation for the study of design should the student continue his studies in the university or elsewhere. University graduates have been notoriously lacking in knowledge of working drawings and simple detail, and it is just here that the technical school lays special emphasis. That this type of instruction meets with the approval of the outside business world is shown by the fact that large companies and corporations have offered to take on any student who completes such a course with the recommendations of his instructor.

The first two years in the university, up to the present time, have been looked upon as a transitional period during which the student was expected to acquire a new set of standards, assimilate the traditions, and become accustomed to the atmosphere of the institution, — find himself. The studies in these two years are largely a matter of reviewing and finishing subjects taken in the high school, — in the engineering college such subjects are mathematics, science, drawing, history, and languages. What engineer or architect does not remember the disappointment that was his upon finding his first year of college mathematics and science was simply a thorough review of his high school work? With closer correlation and sympathy established between the high school and the university, there seems to be no reason why at least one year of this reviewing period could not be eliminated, and the student thus enabled to begin his professional studies immediately. This change does not mean the elimination of cultural subjects, but rather increased opportunity for them. The subject of vocational guidance is being developed, to the end that the student should be enabled to find himself before arriving at the university, and start there with clear and definite ideas as to his future career.

General Considerations. — Before discussing separately the various units of the drawing department it would be well to make note of some general considerations applying to all.

For both freehand and mechanical drawing the student requires a considerably greater amount of floor space than in the classroom. In elementary courses the ratio of space required for drawing to that for classrooms will be about four to three in freehand and five to three in mechanical drawing. These ratios will increase for advanced classes. The arrangements shown in the illustrations (Figure 359) of elementary freehand drawing rooms and (Figure 360) of geometrical drawing rooms show the maximum numbers of students for such classes. The instruction in drawing classes is of necessity largely individual, supplemented at more or less definitely fixed intervals by talks, tests, and discussions, progressively developing the basic principles of the subject. Such a scheme naturally reduces the number of students an instructor can effectively handle. Recognition of the value of individual instruction, possible only in smaller classes, is found in the Smith-Hughes Act, which limits to twenty the number of students of any class complying with its regulations. In freehand drawing the number of students should be limited to thirty in elementary classes and to twenty-four in advanced classes. In mechanical drawing the number of students should be limited to twenty-four in elementary classes and to twenty in advanced classes.

Light. — The problem of light in the drawing room and, in fact, in the whole school is one on which it is difficult to get any consensus of opinion. A northerly light is undoubtedly the best, but means a sacrifice of the warmth and cheer of sunlight. The orientation will depend upon local climatic conditions, and where instructors in charge have definite opinions they should be consulted. In cold damp climates, the warmth and cheer of sunlight will generally be felt to outweigh its disadvantages from the point of view of lighting. In very warm climates, where the sun is to be avoided, the reverse will be true. Let us say then that the light should be unilateral — to prevent the confusion of shadow resulting from cross lighting — and very plentiful, as drawing, especially mechanical drawing, is much more trying on the eyes than the work of the classroom. Particular care should be taken to see that the lighting conditions are as nearly ideal as possible.

For mechanical drawing, the light should come from the front and left of the student in order that he may not be bothered by shadows cast by T square and triangle. It will generally be found most satisfactory to have the student face the light. This statement may occasion some surprise, as one's natural thought is to have the windows to the left of the student. Experience has proved that the light is not often too strong even for the row next to the windows. Frosting the lower portion of the windows removes objection to the strongest light.

The tops of the desks being inclined, the student will not be bothered by the reflection of light in his eyes. To face the light, absolutely removes the possibility of having one's T squares cast a shadow upon the drawing. It will be seen in the illustrations (Figure 360) that for the standard width of classroom this scheme gives the best arrangement. The light at the desks which are cross-hatched is undesirable.

Night Lighting. — More spectacular in its growth even than that of vocational education is the idea of the continuation school. This kind of school makes possible a use of our costly educational plant more than doubling the operation of earlier times, and at only a slightly increased cost. One of the problems that the continuation school adds is that of lighting for night work.

In the night lighting of the mechanical drawing room, the whole room should be lighted by a system of indirect or semi-indirect lights of low intensity, with points of higher intensic brilliancy to the front and left of each student. This double system is necessary, as the simple indirect system of lighting results in a confusion of shadow, severely handicapping the draftsman, whereas the old scheme of drop lights gives a sharp contrast of dark and light — a glare that strains the eyes badly.

Wall Covering. — Each drawing room should contain a blackboard not less than twenty feet in length. The wall opposite the windows will usually be found to be most convenient. Any wall surface below the line of the head of the doors should be covered with a cork carpet, burlap-covered linoleum, or other suitable material, permitting a free use of thumb-tacks to hand drawings, etc. This covering makes possible the use of all the available wall space for the exhibition of drawings, prints, etc. There is no greater stimulus to the interest and activity of the students than the exhibition of their own drawings and those of their fellows.

The concealed wire picture molds and the inlaid cork strip are not only inadequate but unsatisfactory in other ways. The concealed wire is mechanically such a nuisance to operate that it is seldom used if installed. The cork inlay idea has the unfortunate objection that the prints or drawings must cut across the molding. The appearance is very unpleasing.

The walls should be of comparatively low tones — pleasing grays, tans, or browns that harmonize with the woodwork. The low tones will reduce the very distressing reflections. This consideration, especially in the freehand department, cannot be too strongly emphasized. Other general considerations of trim and floor covering are the same as those of the classroom and are dealt with in that chapter.

The Freehand Department. *The Courses.* — The tendency to multiply courses in applied or industrial art has already been mentioned. A brief outline of some of the courses offered should be of value:

I. Elementary Freehand Drawing covers the principles of perspective and a study of tone values in pencil and charcoal. This course is prerequisite to all other courses in drawing and design and fulfills the university requirement. This course covers a period of one year, generally taken during the first year.

II. Advanced Freehand Drawing. In this course other mediums may be employed, such as watercolor or pen and ink. The student adds to his study of line, form, and tone that of color and composition. These courses develop into a great variety of allied or related subjects, such as:

1. Commercial Art. Special emphasis is placed on lettering, color, and composition. The various methods of reproducing posters, etc., and commercial methods are included in the course.
2. Art Metal and other art craft subjects, such as pottery making, weaving, bookbinding, etc. The study of design and technique.
3. Interior Decoration. A course that is often made a requisite in the domestic arts and science department. A study of harmony in color and arrangement of furnishings of the home, etc.
4. Costume Design. This course involves the study of anatomy, history, and design.

The Equipment. — There are two general schemes which find favor in the equipping of the freehand drawing room; each has its advantages and disadvantages. See rooms A and B of Figure 359. For the sake of convenience let us call the first, A, the informal scheme. In this scheme each student has an individual rack on which to rest his pad or board. These racks hold pencils, erasers, etc., and may or may not contain a shelf for the student's books. A foot rest serves to steady the rack. In this scheme separate model stands should be provided, and they should preferably be made adjustable as to height.

The second, or formal scheme, B, utilizes for models and studies large flat tables with a low partition running down the center and serving as a background. The student in this arrangement rests his board or pad on the edge of the table. These tables are made to accommodate from eight to ten students.

The formal scheme gives a fixed and permanent arrangement which greatly reduces the noise and confusion of a multitude of small pieces of furniture arranged in an informal manner. The first scheme makes

FIG. 361. — FREEHAND DRAWING ROOM, OAKLAND TECHNICAL HIGH SCHOOL, OAKLAND, CALIFORNIA.

possible a greater variety of arrangement of studies and lighting. With an adjustable model stand, not only can the model be viewed from all sides, but the elevations may be varied. Added to the noise and confusion of the smaller units, is the difficulty of arranging suitable backgrounds. The informal scheme is the more expensive of the two.

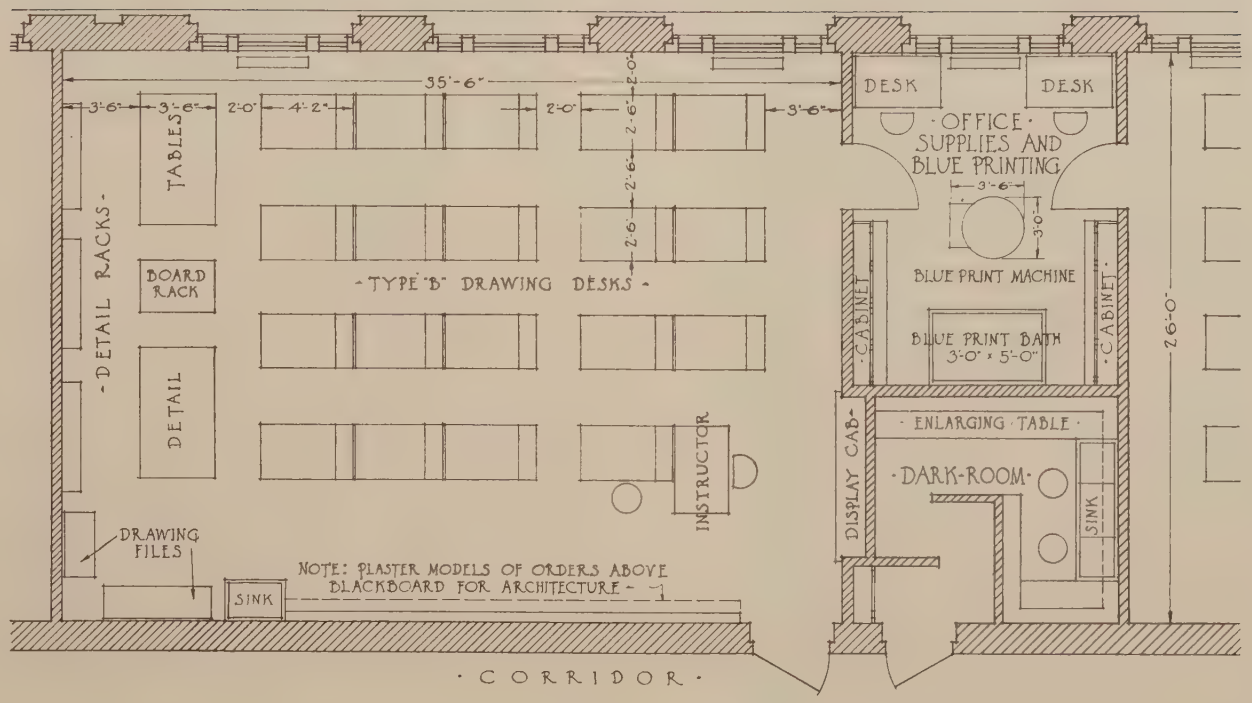
In the classroom the development has been from the old benches, accommodating a number of students, to the present-day individual seats and desks; so in the drawing room there has been a constant change from the larger to the smaller units. Undoubtedly the informal scheme demands more rigid discipline, and it seems that the best freehand teachers are not always the best disciplinarians. When the informal scheme has not proved satisfactory, there has been in almost every instance a lack of discipline or complete equipment. If the informal scheme is given a thorough trial, it will justify itself.

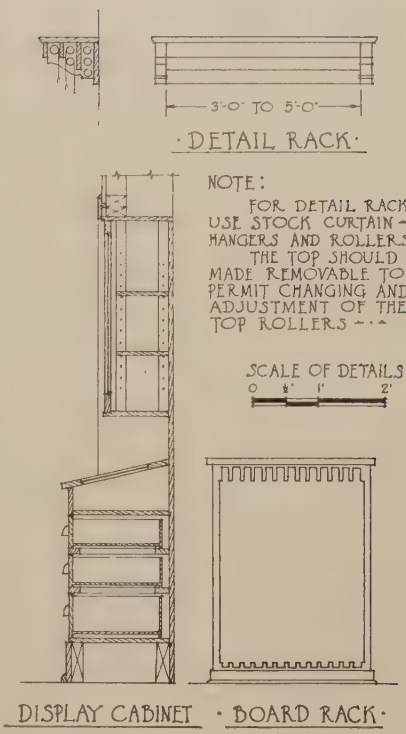
For both the informal and formal schemes, low-backed chairs of oak or other suitable wood will be found most satisfactory. Lighter types of studio or folding chairs, while very desirable for out-of-door work, are too fragile for use in public schools.

Individual lockers should be provided in all drawing rooms. In the freehand rooms they will probably be taken care of most satisfactorily in wall cabinets. There are two types in general use. The one in which each student has an individual key offers the objection that the keys are continually being lost and their replacement, as well as the handling of deposits, is an additional burden to the teacher. The other type, E, Figure 359, has groups of about ten lockers in a compartment to which the instructor only has a key. Three of these compartments will serve a class. This is undoubtedly the best scheme for the freehand drawing rooms.

For advanced classes in watercolor, etc., the equipment noted above should be supplemented with a small, low table for each pair of students. This will provide a place on which to keep their colors, water, etc.

Screens on which to hang models and drawings are desirable for advanced classes, although they are apt to




3'-0" TO 5'-0"
DETAIL RACK
NOTE:
FOR DETAIL RACKS USE STOCK CURTAIN HANGERS AND ROLLERS THE TOP SHOULD BE MADE REMOVABLE TO PERMIT CHANGING AND ADJUSTMENT OF THE TOP ROLLERS
SCALE OF DETAILS
0 ½' 1' 2'
DISPLAY CABINET
BOARD RACK

ADVANCED TECHNICAL DRAWING ROOM

FIG. 362.

interfere with the lighting of the interior of the room. Those shown in Figure 361 are too high. The height of the blackboard is about right. These screens would be improved if there was a shelf on each side instead of the one shown. The additional shelf would make the screen equally desirable and usable on both sides.

For commercial art and design classes, mechanical drawing desks are the most satisfactory. For costume design large flat tables are desirable, as they afford freedom in laying out patterns, stencils, etc., which the smaller units do not. The artcraft courses offered will depend entirely upon local conditions and demand, and the special equipment required should be determined by consulting with the instructor in charge.

The Mechanical Drawing Department. *Courses.* — In this mechanical drawing department the courses usually offered are:

I. Geometrical Drawing. This course covers the use of the instruments, the elements of geometry as applied to drawing, projections, and some perspective. It satisfies the university requirement and is prerequisite to any course in advanced technical drawing. The course covers a period of one year, taken during the second year, if it is to be followed by advanced drawing. The periods are from one hour to one hour and a half a day.

II. Trade Drawing. This course will generally be arranged to fulfill the requirements of the Smith-Hughes Act. The students in this group are to become mechanics, electricians, carpenters, etc. As they take but one period of drawing per day, the course is designed primarily to enable them to read and work from blue prints and to lay out their work properly. The course includes plates of essential geometrical problems, projections, and sketching. This course requires an extensive library of working drawings, as one does not learn to read blue prints without the blue prints. The number of students is limited to twenty.

III. Advanced Technical Drawing. Upon completion of the course in geometrical drawing, the students may elect any one of a number of courses in advanced technical drawing, such as:

1. Machine Drawing.
2. Architectural Drawing.
3. Ship Drafting.
4. Mapping, etc.

Elementary freehand drawing and geometrical drawing are prerequisite to all such courses.

The student in these courses first draws and traces full size or large scale details, thus getting acquainted with the elements he is to use later in the small scale assembly working drawings. These will be followed by the complete working drawings of a gas engine, a house, etc., depending upon the course the student elects. The elements of design are introduced progressively, and the work in the drafting room is supplemented by related work in the shops, science, and mathematics departments. Thus the student gains a knowledge of materials, an essential to any serious work in design. By the use of laboratory methods, such courses as graphic statics and strength of materials may be effectively given in the high school.

The Geometrical Drawing Rooms (Figure 360). — The number of students in geometrical drawing classes should not exceed twenty-four. The equipment will consist of the four-locker type "A" desks, such as shown in Figure 360; a small drawing board 16″×21″ for each student; a print rack and drawing file; a desk and chair for the instructor.

There should be no stools in any geometrical drawing class where the periods do not exceed an hour and a half in length. The stools make a great deal of noise and increase the necessary janitor service. It has been found that the students do a great deal more and better work if they stand. Since there may be a number of students who are unable to stand, a few stools should be provided. These stools will be kept in the storeroom when not needed.

The desk of standard height will prove too high for some students, and so a few low platforms will be found necessary. Adjustable tops to the desks are probably inadvisable. The average boy will be inclined to go the limit with any adjustment, and, as a consequence, the inclination of the top of the desk will be too great, causing pencils, ink, etc., to fall to the floor. Again, parts will frequently be broken or lost — school equipment should be not only fool-proof but boy-proof. Another objectionable feature of adjustable tops is the open space which serves as a catch-all for papers, dust, and dirt.

The lockers should not be less than three inches wide in the clear and large enough to accommodate a twenty-four inch "T" square. There should be a shelf four to six inches from the top for the ink instruments, etc. The lockers should be provided with good locks, as instruments are expensive, and the danger of their loss should be minimized. The four lockers will accommodate the three day-school classes and one continuation class for which the room should serve.

A blue-print rack to hold the small scale prints should be provided. This may be combined with the drawing files. Drawings should not be kept in the students' lockers, as they are certain to be damaged.

The Trade Drawing Room. — Here the number of student desks will be limited to twenty. The desks

should be of the type " B," containing six lockers, as the classes are small and often in session for periods of only forty minutes, so there will be more of them to provide for. Besides the filing cabinet for drawings, there should be a model cabinet for the shop models, and a filing cabinet for the library of working drawings. The instructor should have a drawing desk in addition to the regular teacher's desk and chair.

The Technical Drawing Room (Figure 362). — An advanced technical drawing class should not exceed twenty in number. The equipment will consist of type " B " six-locker desks (see Figure 360), as these rooms will be in demand for continuation school classes. A number of large detail tables should be provided, and some large drawing boards in addition to those which go into the lockers. These could be kept in the table serving the detail tables (Figure 362). The filing cabinets for drawings should be more elastic than for geometrical drawing classes, when the drawings are of a single standard size.

The machine drafting room should contain display cases for machine parts, etc., which the students study and draw (Figure 362).

In the architectural drawing room, plaster models of the orders will make possible a better understanding of the classic form and afford an ideal comparison of the orders. The five feet or so above the blackboard might well be used for this purpose.

In the technical drawing classes some such scheme for a detail rack as suggested in Figure 362 will prove very useful. Typical details at full size or a large scale for reference and instruction are absolutely essential. A roller arrangement is a very convenient one. The instructor should have a drawing desk for his own use, as he will have constant need of one.

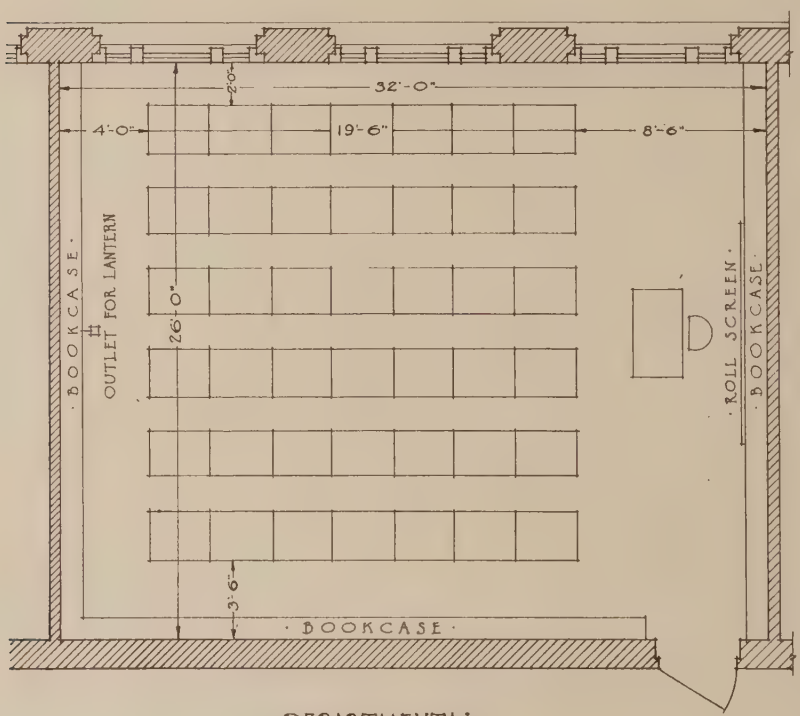


Fig. 363.

Some Rooms in the High School. — *The Library, Lecture Room, and Study* (Figure 363). — One of the real problems to be met with in any large high school is that of proper studying accommodation. For best results, study rooms should not be larger than classrooms.

Departmental libraries bring the special books, magazines, and catalogues to the department where they are used and reduce the congestion in the main library. This latter consideration is very important, as large groups in high school are not conducive to good discipline or satisfactory study.

In the drawing library, the instructors of the department would be in charge, and the students majoring in the shop and drawing departments would be the ones to study there. This room could meet the need of a lecture room for the department, and if necessary, could serve as a classroom. For lantern slides an aluminum painted curtain and a base receptacle should be provided.

Offices. — Small offices should be provided, each to accommodate two or three teachers. These offices afford privacy for rest, work, and conferences with fellow teachers or students. Large rest rooms for teachers are unsatisfactory. The privacy is lost, and one cannot rest when many are free to use the room. Again, when the school grows, any rest room of size is certain to be turned into a classroom. This is a mistake, as it not only leaves the teachers no place to go, but makes an unsatisfactory classroom.

The head of the department will keep in his office files of all drawings made on order of the Board, the principal, or other authorized parties. These will include drawings made for work to be done in shops.

Store and Blue-print Rooms. — Ample storage space should be provided for the departmental supplies of tracing-paper, cloth, detail paper, inks, colors, etc. In

Mr. Wm. B. Ittner, Architect.

FIG. 364. — MECHANICAL DRAWING ROOM, GROVER CLEVELAND HIGH SCHOOL, ST. LOUIS, MISSOURI.

Figure 362 an arrangement combining the office for two teachers with the storeroom and blue-printing room is shown. This is a desirable arrangement as it affords more definite supervision over the supplies and blue-print apparatus. Such a scheme will insure the making of blue prints in a neat, workmanlike manner, and without undue waste of materials.

The tendency in schools has been to make shift with a simple blue-print frame carried by hand to the nearest accessible sunlight — when there was sunlight. Such an arrangement is, of course, inadequate where technical and trade courses are offered, demanding large numbers of blue prints. When the blue-print room has a sunny exposure, the cheapest satisfactory arrangement is one consisting of tracks on which the blue-print frame is run out through a window to the sunlight. There should be adjustments to bring the glass to a position perpendicular to the rays of the sun. This scheme has the objection of being unsightly, and the tracks on the window sill offer difficulties in making it weather tight. Another scheme somewhat more expensive is to have the blue-print frame mounted on a carriage. Where the sunlight is readily accessible this arrangement will prove very satisfactory. If it is necessary to build a special platform or balcony for the exposure, the expense will count against it.

The electric blue-printing machine is the most desirable in every way. A vertical cylindrical blue-print frame can be installed at an expense not greatly exceeding that of the preceding scheme with a platform or balcony, and all dependence upon the sun is removed. This is important, as the demand for blue prints is not regulated by the sun. Blue-printing for and by evening school students becomes possible with the electric machine. In addition to these considerations the experience of using an electrical machine will prove of real benefit to the student who goes to work for a company or corporation which does its own blue-printing.

The blue-print bath should be generous in size, say $3' 0'' \times 5' 0''$. For drying, wires may be strung across the room at a convenient height.

Dark Room. — In any school of size a dark room will prove very useful. The room will be used largely by the instructors in the drawing and science departments,

Mr. Wm. B. Ittner, Architect.

FIG. 365. — FREEHAND DRAWING ROOM, GROVER CLEVELAND HIGH SCHOOL, ST. LOUIS, MISSOURI.

but will also serve for advanced students in commercial art and printing, photographic work of all kinds — the making of plates, and slides of lecture and laboratory purposes can be done here.

The arrangement shown gives ample working space and accommodation for two persons to work at once. Too much space is equally as objectionable as too little. One should, as far as is possible, be able to reach from one position everything that may be needed.

An ordinary narrow porcelain kitchen sink is the most satisfactory. A wooden mat, resting on the drainboards and extending over the sink, serves to keep the trays on a level. In the main, plentiful open shelving, six to eight inches deep, is more desirable than cabinets with doors. A small cabinet with locks for material and equipment of value should be provided. A table not less than six feet in length should be provided for enlarging, etc. The approach or entrance to the dark room (there should be but one) should be so arranged that a person may enter without admitting light. The small cross partition should extend only far enough to cut off any direct rays of light. The approach should be painted black to prevent reflections, but the interior of the dark room, where the light is controlled, should be light in tone.

Summary. — There is a very definite demand being made upon the drawing departments of our public schools for instruction in vocational drawing of every description. This is true of both freehand and mechanical drawing. This demand must be met with properly equipped drawing rooms and capable instructors. The old idea that a person with a bachelor's degree and a teacher's certificate is fitted to teach anybody anything must be modified if we are to gain and hold the respect of the outside business world. Technical drawing instructors must have, in addition to their special technical training, actual practical experience if they are to render the service that is expected of them. The almost universal weakness of our shop departments has been that the men who had the necessary experience as machinists, carpenters, etc., did not have the necessary technical and educational qualifications. The tendency and danger in technical drawing subjects is of the opposite nature but equally objectionable.

In public schools special rooms for drawing are probably inadvisable until the intermediate grade is reached.

Special teachers are more necessary than special rooms. For obvious reasons the width and height of rooms will generally be the same as those established for the classroom. For the elementary freehand and mechanical drawing work in the high school the standard size of classrooms will prove satisfactory. The advanced classes will require more room.

It will often be necessary, or at least be good policy, to have the same room serve for geometrical drawing and advanced technical drawing. The room should, of course, be arranged and furnished as an advanced technical drawing room. If the maximum number of students possible in geometrical drawing is to be accommodated, the room must be larger than that shown in Figure 362.

The lighting of drawing rooms should be given special attention. Local climatic conditions are to be considered, and the opinion of the instructors in charge should be consulted. The lighting should be unilateral (from one side) to avoid confusion of shadows. Figure 364 shows a good drawing room which would have been improved by the omission of the smaller windows. For freehand drawing, the scheme of inclined windows shown in Figure 365 is very good, and is recommended where cost and structural conditions permit.

A small departmental library, which may serve as a lecture room and study, will prove to be of great value. The technical books, magazines, and catalogues will then be located where they will do the most good. There will be a vast saving of time and prevention of unnecessary crowding in the main library.

Small offices, combined with storerooms, blue-print rooms, etc., to take up the depth of a classroom, are most desirable.

The drawing department, when possible, should be located in or near the center of the group of related subjects. These are the shops, the science, and home economics departments. The shops will naturally be farthest removed from the purely academic department, and the drawing department will generally be found to fit best between the shops and the other two departments.

CHAPTER XXII

THE INDUSTRIAL ARTS DEPARTMENT

By Walter A. Tenney, *Principal of the Vocational High School, Oakland, California*

General Remarks. High School Shops. Location. Lighting. Correlation. Demonstration Room. Wash and Locker Rooms. Offices. Number of Students to Classes. Power. Pattern Shop. Grinding Room. Machine Shop. Foundry. Forge Shop. Automobile Shop. Electrical Shop. Plumbing Shop. Sheet Metal Shop. Cabinet Shop. Carpenter Shop. Exhibit Room. Central Storeroom. Intermediate or Junior High School Shops. Conclusion.

General Remarks. — Educational thought has, for a number of years, had a pronounced and well-nigh universal trend towards a wider recognition of the need for industrial and vocational education. The idea, that the modern school system should serve the needs of "all the children of all the people," has been generally accepted, not only among educators, but among thinking men and women in all walks of life. There is an insistent and growing demand that the work of the school connect more closely with the future work of the students, — that in addition to the cultural studies there should be training preparatory to the work which the students will do for a livelihood.

Since a majority of students, upon leaving school, engage in some form of commercial or industrial work, it follows that a democratic school system must provide courses and equipment which will prepare such students for the lives of activity they will enter with the same care and thoroughness with which other students are prepared for a professional career. Therefore, any study of modern school architecture must give prominence to the planning and arrangement of the rooms devoted to industrial and vocational training, — in other words, to the Industrial Arts department.

The intelligent designing of a school building must have as the fundamental basis of all planning, a consideration of the activities to be carried on within the building. In planning any particular room or group of rooms the architect and school man must consider first the nature of the work to be done, the number of pupils to be accommodated, and the necessary equipment. These three factors will determine the size, character, and arrangement of the rooms to be built; the funds available, of course, being a determining factor in the quality of building.

In a work of this kind it is impossible to give plans that are directly and completely adaptable to the needs of all communities, and all types and grades of schools. This chapter will attempt to give typical examples of what are thought to be good arrangements for shop or manual training rooms, and to discuss briefly the fundamental elements which form the basis in planning similar units in any school, in the hope that architects and school officials may find here some assistance in the solution of their problems.

The High School Shops. — The high school of the future, in all large communities, will undoubtedly be what is known as the cosmopolitan or inclusive high school. Because such a school would offer the greatest possible number of courses, and would furnish the greatest amount and variety of equipment, to be found in any high school, it will be used here to illustrate typical high school installations.

The first question to answer is, what kinds of industrial training shall be given? What shops shall be built and equipped? Local needs and conditions may lead to the emphasis of one or another particular industry, but in general, there are certain forms of industrial training that are common to all localities, certain trades which are basic, which form the foundation for many hundreds of specialized occupations. Such is the machinist trade. Its principles and processes are found in thousands of occupations, from the making of a watch to the building of a locomotive. These basic trades, then, should make up the main part of the industrial arts department. The machinist, blacksmith, foundry, and pattern-making trades form what might be called the iron trades group. These should be installed in the large inclusive high school.

However, the installation of the high school foundry is a debatable question. A really practical foundry with up-to-date equipment including cupola, traveling crane, etc., will cost to equip $8000 or $12,000 in addition to the cost of the building. But few boys whose desire for

Mr. John J. Donovan, Architect.

FIG. 366. — OAKLAND TECHNICAL HIGH SCHOOL SHOPS, OAKLAND, CALIFORNIA.

education holds them through the high school period will take up foundry work as an occupation. If the supplying of castings to the machine shop is argued as a reason for putting in a school foundry, it should be remembered that the castings so obtained are quite likely to be inferior, and to cost as much or more than if obtained from a commercial foundry. It is sometimes thought desirable to give a certain amount of foundry work to the pattern maker and machinist students, that they may gain some knowledge, through practical experience, of this trade which is so closely related to their own. It is very doubtful, however, if either the educational or practical value of such a course would justify the expense. Nevertheless, foundries are established in many of the large high schools, therefore a typical installation will be considered in this discussion.

Automobile mechanics is a special branch of the machinist trade, yet so great and so widespread is the demand for this work that the large school should have a separate shop for it.

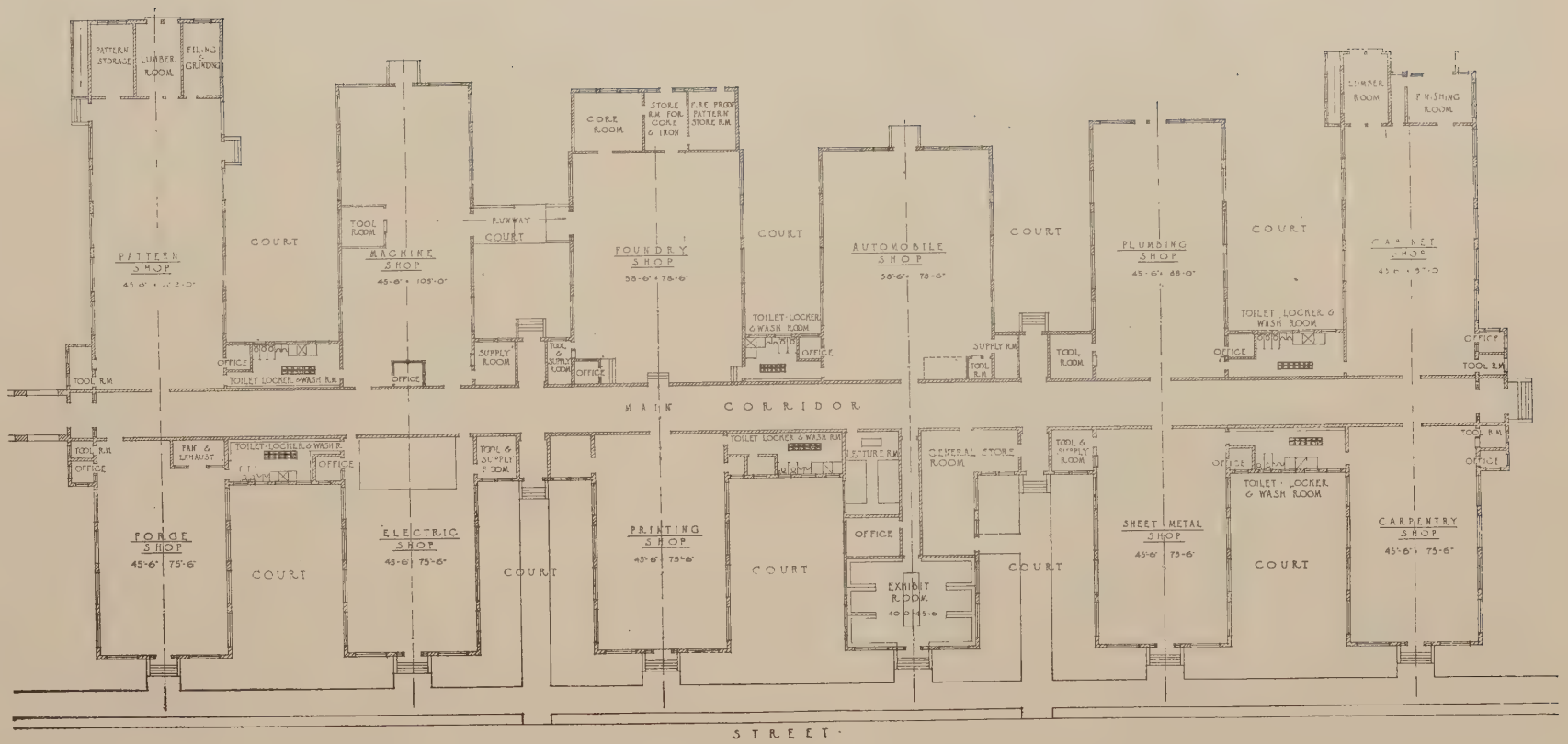
This is the age of electricity. Its applications are increasingly numerous. A thorough practical and theoretical knowledge of electricity will lead to employment in many different fields, making this one of the basic trades. An electrical shop, then, will be included in our plan.

Plumbing and steam fitting, sheet metal work, carpentry, and cabinetmaking comprise the building trades group. These occupations are demanded in every community. Cabinetmaking might be taught in connection with carpentry, using the same shop and equipment, but in the large school these departments should have separate accommodations.

Printing is an occupation found in every community. It has a decided vocational value, and with its related courses in English, history, and journalism has an educational or cultural value probably unsurpassed by any course in the high school.

The trades above named are common to all urban communities, and many of them are so basic that the graduate student, if he possesses the quality of adaptability, will be able to apply his knowledge to any one of a great variety of occupations. The inclusive high school in the larger cities should provide for most or all of these in its plan for instruction.

Location. — The next question to consider is the location of the industrial arts department. The ideal arrangement is to have the shops in a separate building or group of buildings, and where sufficient land is available all on the ground floor. The initial cost is somewhat greater for this type of construction, but it has decided advantages. Figure 366 gives an exterior view, and Figure 367 gives the floor plan of the industrial arts department of the Technical High School of Oakland, California, an example of the type of building above referred to, in the designing of which the writer



GENERAL PLAN OF SHOPS FOR A LARGE COSMOPOLITAN HIGH SCHOOL

SCALE 0 20 40 60 80 100

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FIG. 367.

collaborated with the architect. While this example is not presented as a perfect solution of all the problems of school shop planning, it has many points of excellence and superiority over those of other school buildings throughout the country, which commend it to the study of architects and boards of education.

Where the above arrangement cannot be secured, owing to lack of building space or funds, the next best arrangement is a separate building of more than one story. And last and least desirable of all, is where, as in a thickly populated city with limited building area, the whole school, shops and all, must be housed in one large building of many stories.

When building under either of the two last-named conditions, the shops having heavy equipment and handling heavy materials, such as machine shop, forge shop, and foundry, should be located on the ground floor, and in the event of the shops being located in the same building with the rest of the school, care should be taken to isolate them as much as possible, and to separate them by specially constructed walls and floors from classrooms which would suffer from the noise or vibration of machinery.

Lighting. — One very important feature in planning the shop building, and one which is often neglected to the discomfort and possible injury of the students, is the lighting. Not only is the quantity of light, but also the angle at which it falls upon the work, of the greatest importance. Skylights have often been resorted to in shop buildings, and have found numerous advocates. In the opinion of the author, there is only one condition under which skylights are permissible, and that is when the building is so situated that it is impossible to obtain sufficient lateral lighting. The proper lighting for school shops is the modern factory lighting, in which the walls consist mainly of a series of supporting columns with the intervening spaces filled with glass set in steel sash. Figure 366 illustrates an excellent example of proper and adequate shop lighting. On the east, south, and west sides, it is advantageous to have the windows glazed with ribbed or diffusing glass. On the north side, plane glass is preferable.

Correlation. — In a large group, such as is here contemplated, the position of individual shops with relation to each other should be considered. For example, the metal-working shops should be grouped together. The foundry and machine shop especially should be adjoining each other, and it is desirable to have the pattern shop not too far removed. As a general rule, it might be stated that the shops in which the work is of a similar nature, is interrelated or dependent upon each other, should be grouped together as far as possible.

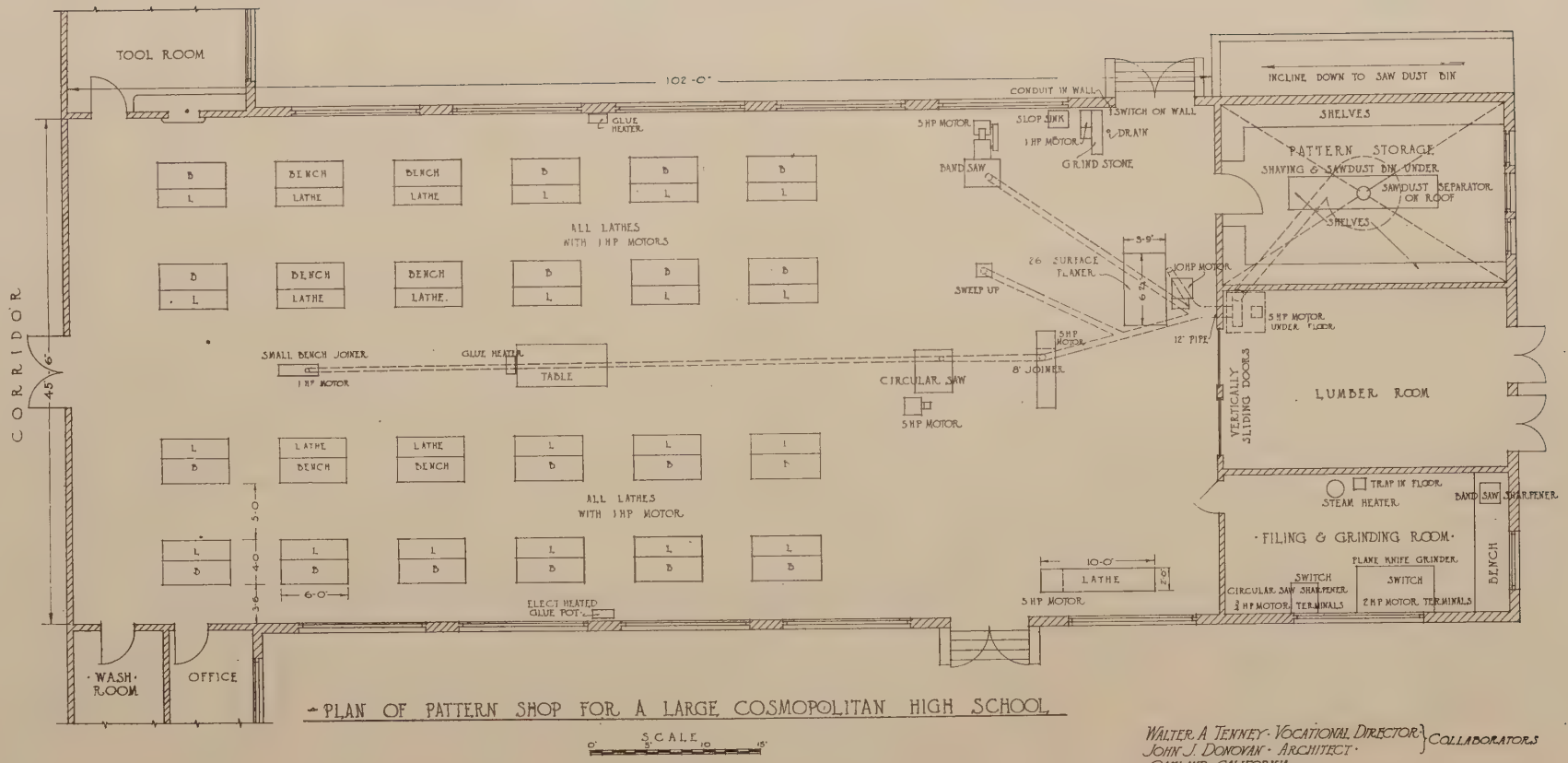
Demonstration Room. — In many schools a so-called demonstration theater is provided in one end or corner of each shop. In a "class A," or even less expensive type of building, where every square foot of floor space means an outlay of many dollars, this is, in most instances, an expense for which there is inadequate return. It is found that these demonstration theaters are in use but a very small proportion of the time. Therefore, if one lecture and demonstration theater can be located so as to be reasonably accessible to all the shops, it will serve all purposes, and effect a great saving both in floor space and equipment. Reference to Figures 367 and 400 will show how such a plan was worked out. This room is provided with blackboard, demonstration tables and benches, also with an electric cabinet furnishing current both direct and alternating and of various phases and voltages, for electrical demonstrations or for furnishing power to operate machines for demonstration purposes. The room is also arranged for stereopticon or moving picture work and may be darkened for this purpose in the daytime.

Wash and Locker Rooms. — Wash and locker rooms should be provided, within easy access of the shops. The washroom should be supplied with both hot and cold water. A very satisfactory method is to install an automatic gas water heater with thermostat. This will insure a constant supply of water of the proper temperature. A portion of the washroom should be separated by partitions for toilets and urinals, the number depending on the number of pupils to be accommodated. The lockers may be installed in the same room as the washstands. This is a very satisfactory arrangement, as it saves time and confusion of pupils running about from room to room between classes. Figure 367 shows a wash and locker room for each two shops.

Offices. — Each shop should also have a small office for the instructor, and a tool and supply room. In some of the shops a supply or storeroom separate from the tool room is needed, in which to keep finished or unfinished work and supplies which it is sometimes advisable to draw in considerable quantities from the central storeroom. If a central storeroom for the entire school plant is not maintained, the supply rooms for individual shops will need to be larger in some instances. These accessories are all shown on the floor plans which illustrate this chapter.

Number of Students to Classes. — The next question to consider is the number of students in a class. This will depend on whether the school is to conduct strictly vocational classes, or general manual training classes, or both.

The passage of the Smith-Hughes Act has given a great impetus to vocational education, and doubtless under this influence most large high schools will offer vocational courses. These courses are now being intro-



PLAN OF PATTERN SHOP FOR A LARGE COSMOPOLITAN HIGH SCHOOL

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FIG. 368.

FIG. 369. — PATTERN SHOP, OAKLAND TECHNICAL HIGH SCHOOL, OAKLAND, CALIFORNIA.

Mr. John J. Donovan, Architect.

duced in many of the college preparatory or classical high schools, which had previously given no attention to such work. One result of this law has been to limit the number of students in a class. It is generally agreed by experts that fifteen is the maximum number that can be taught with success in trade classes, and this is the limit fixed by law in some states, though in others a maximum of twenty is allowed, with the idea that the actual average attendance will be about fifteen. If strictly vocational classes are to be maintained, then the number of students to be provided for in a class will be fifteen to twenty.

In so-called technical high schools, where shop work is given not with a view to teaching any particular trade, but to giving a general knowledge of a number of trades to boys who will perhaps later go to college and become engineers, or administrative officers, or at least will hold positions in industry other than that of mechanics, twenty-four is considered about the ideal number in a class. A larger number is sometimes admitted, but the results are less satisfactory.

Fig. 370. — Pattern Shop Bench.

The shops illustrated in Figures 366 and 367 are equipped to accommodate a maximum of twenty-four students in a class. The equipment for these shops was selected and installed by the writer with a view to giving a high grade general manual training course to technical high school students. If planning for a strictly vocational or trade course, equipment for fifteen to twenty students would have been provided and the largest shops might have been slightly reduced in size. The shops here shown are forty-five feet in width and vary from sixty to one hundred feet in length. Figure 367 shows a further development by the author of the same general arrangement as shown in Figure 40. This is a larger and more complete shop plant, and has advantages in arrangement both of buildings and equipment.

By a small addition to the equipment of the shops here shown and the employment of an additional teacher, two classes can be accommodated in one shop. Where there is a large number of classes, this plan effects a considerable saving both of room and equipment. Either two full-time day classes or one full-time and one part-time continuation class may be taught at the same time in one shop. And since there is nearly always a number of machines in a shop, particularly the larger and more expensive ones, which can be used only part of the time by one class, this arrangement allows double the number of students to use them without the purchase of additional equipment.

Power. — The individual motor drive for the greater part of the shop equipment will be found most satisfactory. Though the initial cost of installation is more, the cost of upkeep and operation is less, due to the fact that if only a part of the machines in a given shop are running, there is only sufficient power used to run those few machines, instead of running a large motor and long lines of shafting. Another advantage is that, with the individual motor drive, a machine may be moved at any time and set in any part of the shop, or turned at any angle, by simply running wires to the motor, which cannot be done if line shafting is depended on to transmit power. If the machines are belt driven, then the roof trusses or ceiling joists must be made stiff enough to support the transmission machinery which will have to be provided. This will include hangers shafting, pulleys, belting, etc.

The Pattern Shop (Figure 368). — This shop must have floor space for both bench and machine equipment, and for assembling large work. A lumber storeroom must be provided convenient to this shop, also a storeroom for finished patterns, and a filing and grinding room, which is described later.

The bench equipment should consist of one work bench for each member of a class, each bench equipped

with side and tail vises, the side vise to be quick acting. A very satisfactory bench designed by the writer and made in the school shops for use in the high schools of Oakland, California, is shown in Figure 370. The bench contains an individual drawer for each student. Each drawer is equipped with the following tools:

One bench knife
One 2′ rule.
One $\frac{1}{4}$″ chisel.
One $\frac{1}{2}$″ chisel.
One $\frac{3}{4}$″ chisel.
One 1″ chisel.
One $\frac{1}{4}$″ auger bitt.
One $\frac{3}{8}$″ auger bitt.
One $\frac{1}{2}$″ auger bitt.
One $\frac{3}{4}$″ auger bitt.
One 1″ auger bitt.
One block-plane cutting-iron.
One smooth-plane cutting-iron.
One jack-plane cutting-iron.
One pair 8″ outside calipers.
One $\frac{1}{2}$″ parting tool.
One $\frac{1}{4}$″ turning chisel.
One $\frac{1}{2}$″ turning chisel.
One $\frac{3}{4}$″ turning chisel.
One 1″ turning chisel.
One $\frac{1}{4}$″ turning gouge.
One $\frac{1}{2}$″ turning gouge.
One $\frac{3}{4}$″ turning gouge.
One 1″ turning gouge.
One oilstone slip.

The cabinet, on the end of the bench, contains the tools used by the students in common. They are as follows:

One $1\frac{3}{4}$″ block plane.
One 2″ smooth plane.
One $2\frac{3}{8}$″ jack plane.
One 6″ sliding T bevel.
One 6″ try square.
One 6″ dividers.
One marking gauge.
One claw hammer.
One oil stone 2″×7″ in box.
One oil can.
One mallet.
One nail set.
One spoke shave.
One bitt brace.
One countersink.
One wood drill No. 4.
One wood drill No. 5.
One wood drill No. 6.
One wood drill No. 7.
One screwdriver.
One backsaw.

When individual sets of tools are provided, the drawers must have locks. A bench with four drawers as shown will accommodate four classes. A system of locks for these benches should be ordered from the factory, no two alike, but under one master key, and made up in sets of five locks each. The first four locks, of each set, will be put on the drawers, the fifth on the end cabinet. The first four keys are fitted so that each will open its own drawer, also the end cabinet, but will not open any other lock in the system.

A supply of extra lathe tools, pattern makers' shrinkage rules, pinch dogs, large-sized inside and outside calipers, sets of flat, medium, and regular sweep inside and outside ground gouges, one core box plane, one adjustable curved face plane, one large jointer plane, extra hand-rip and crosscut saws, steel squares, etc., should be kept in the tool room.

A 12″×60″ speed lathe with inside and outside face plates should be furnished for each student. The lathes should be placed as shown in Figure 368, giving each student a bench and lathe with outfit of tools as his complete working unit. The bench and lathe together require floor space 4×6 feet, and should be placed from four to five feet apart.

The machinery equipment for this shop should be:

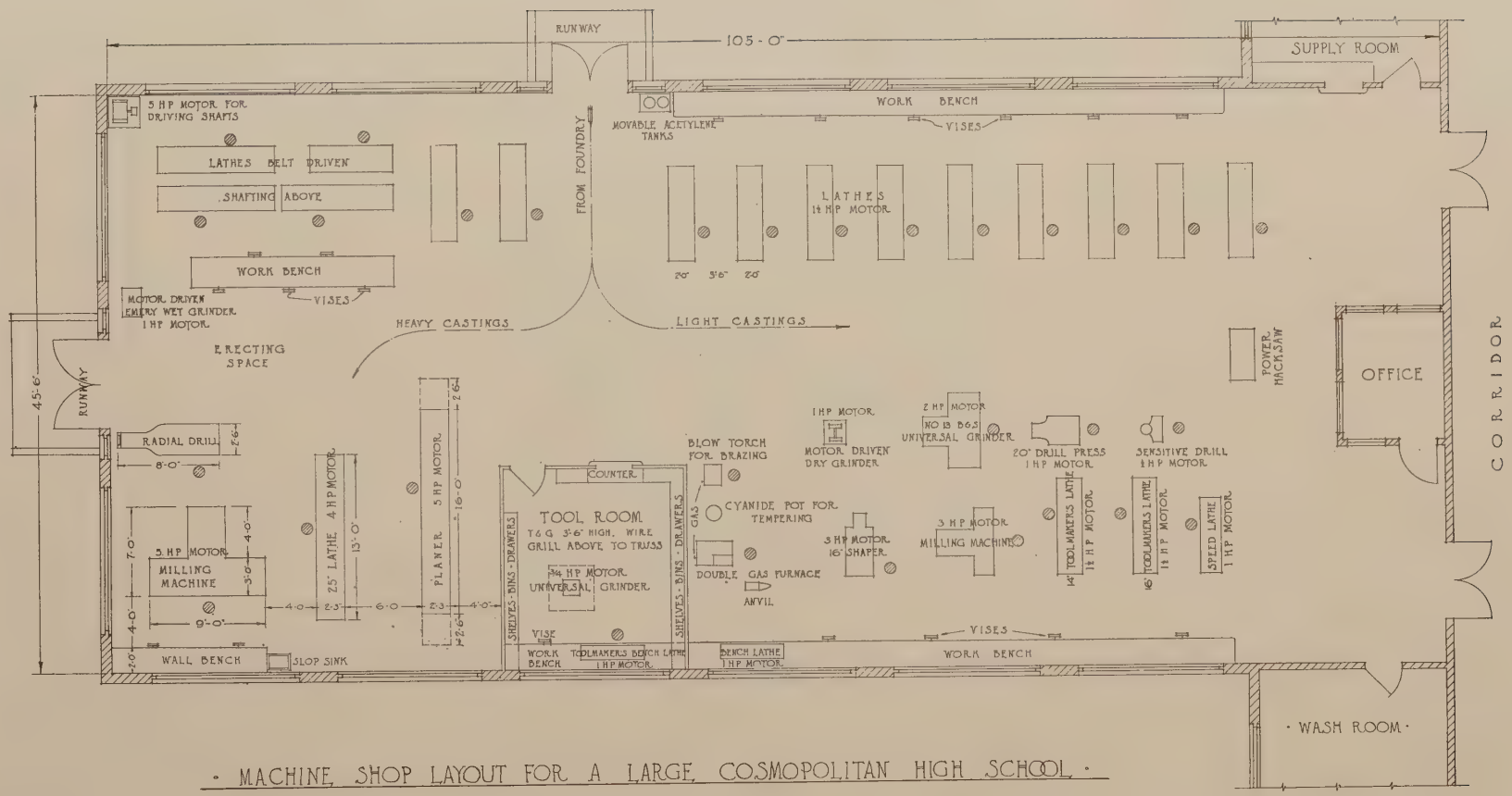
Machine	Floor Space	Horse Power
1 16″ or 18″ universal circular saw, with motor	4′ 5″× 5′ 6″	5
1 36″ band saw, with motor	3′ 0″× 6′ 2″	5
1 24″ cabinet planer, with motor	6′ 3″× 6′ 6″	10
1 12″ jointer or buzz planer, with motor	2′ 9″× 8′ 2″	3
1 20″×10′ pattern lathe, with motor	2′ 6″×10′ 6″	4
24 12″×60″ lathes, with motor	2′ 0″× 5′ 3″	1 each
1 5″×40″ grindstone, with motor	2′ 0″× 4′ 0″	1
1 large wood trimmer	2′ 2″× 4′ 0″	Hand
2 small wood trimmers, which will set on the work benches and may be carried from bench to bench as needed		

The pattern shop should also have one or more glue heaters, and a large table centrally located for laying out and assembling large patterns, and another for varnishing, also a large supply of both wood and iron clamps of various sizes. A truck, for carrying materials from place to place about the shop, from machine to machine, or from shop to shop, is very desirable.

The saws and planers should be provided with hoods and piping for taking out the shavings and sawdust. This also necessitates a shaving exhauster and motor to drive it, also a shaving separator and bin. If the shops are of wooden construction the shaving bin should be a small brick or concrete structure and separated from the other buildings. The installation of the shaving exhaust system is shown in Figures 368 and 394, where the exhauster and motor are under the floor (it might also be placed overhead), the shaving separator above the roof of the lumber or pattern storerooms, which are lower than the main building, and the shaving bin is under the floor of these respective rooms, with the outlet pipe from the separator leading vertically down through the center of the room. The shaving exhaust system eliminates breathing of dust by students, and is thus a health protection as well as a means of keeping the shop cleaner and more attractive in appearance.

Safety guards should be provided for saws and planers, and also belt guards wherever needed.

The Grinding Room. — In addition to the accessories and equipment named above, provisions must be made for sharpening the planer and jointer knives, and the circular and band saws. The ideal arrangement is to have a separate room about 15×20 feet in which should be installed the following equipment:



MACHINE SHOP LAYOUT FOR A LARGE COSMOPOLITAN HIGH SCHOOL

SCALE,
0 5' 10' 15'

NOTE. ◎ INDICATES POSITION OF THE STUDENT.

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FIG. 371.

FIG. 372. — MACHINE SHOP, OAKLAND TECHNICAL HIGH SCHOOL, OAKLAND, CALIFORNIA.

Mr. John J. Donovan, Architect.

Mr. Floyd A. Naramore, Architect.

FIG. 373. — BENSON POLYTECHNIC HIGH SCHOOL MACHINE SHOP, PORTLAND, OREGON.

MACHINES	FLOOR SPACE	HORSE POWER
1 30″ Automatic plane-knife grinder . .	4′ 0″ × 7′ 0″	2
1 Automatic circular-saw sharpener . .	2′ 6″ × 2′ 6″	¾
1 Automatic band-saw sharpener . . .	1′ 6″ × 2′ 8″	½
1 Automatic band-saw setting-machine .	1′ 0″ × 1′ 0″	¼
1 Trip hammer circular-saw set	1′ 0″ × 2′ 0″	Hand
1 Circular-saw swage	1′ 0″ × 2′ 0″	Hand

The first two machines may be had with individual motors on the machines. There are several types of band-saw sharpeners. The one that holds the saw in a horizontal position will require a bench about 2′ 10″ × 8′ 0″ to hold the machine and the two wheels which carry the saw. Another type carries the saw in a vertical position, hung on a wheel high up over the machine. This latter type requires only about 1′ 6″ × 1′ 6″ floor space.

The band-saw setting machine requires only about one square foot of space, the circular-saw set and swage about two square feet each. One long bench or two smaller benches can be arranged to carry the band-saw filer, hand-saw setter, circular-saw set, and swage. The first two should be power operated. A small shaft can be installed under the bench, with pulleys and belts from which to drive both machines. Together they will require only one-half horse power. The two latter machines are hand operated.

This room should also have a case or cabinet with drawers or shelves for containing the grinding wheels, files, wrenches, and other supplies for operating the machines, and racks for holding the band and circular saws.

One filing and grinding room equipped as described will suffice for all the woodworking shops in the school plant.

The Machine Shop (Figure 371). — This illustration shows a very satisfactory arrangement of equipment in the machine shop, benches against the wall, machines placed near the windows to get good light, and ample space in the center of the shop for erecting and assembling work. It also indicates the routing of material through the shop.

Either a long continuous bench with drawers underneath and vises placed at intervals, or an individual bench such as shown in Figure 374 may be used. Since a large part of the class is likely to be working on the machines most of the time, it is not absolutely necessary to have a separate bench for every student in the class; but enough drawers must be provided so that each student may have a separate lock drawer for his equipment. With twenty-four students in a class, if double periods are given, four classes would be taught daily. This would require 96 drawers. If continuation classes are also taught in the same shop, additional drawers should be provided for them. The drawers should be of generous size to afford the student ample room to store his individual tools, working clothes, and small pieces of unfinished work. The drawers shown in Figure 374 are about 1′ 6″ wide, 1′ 9″ long, 9¾″ deep.

FIG. 374. — MACHINE SHOP BENCH.

The individual equipment for each student consists of:

One combination square with 6″ scale.
One pair 6″ inside firm joint calipers.

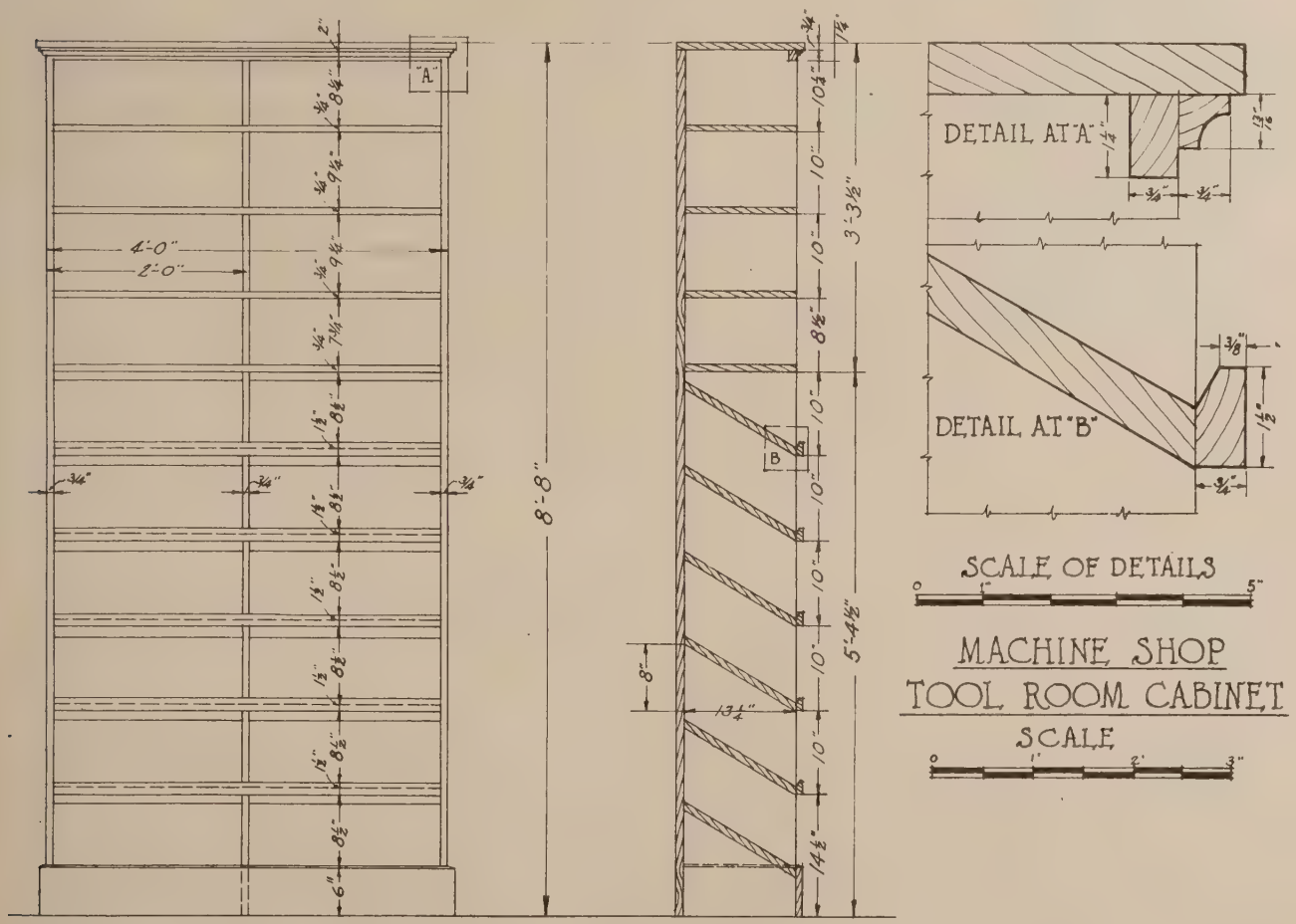


FIG. 375.

One pair 6″ outside firm joint calipers.
One center gauge.
One machinists' hammer.
One center punch.
One or two chisels.
One pair 6″ dividers.

This is the most expensive of all the shops to equip. The machine equipment for a class of twenty-four should be as follows:

Machine	Floor Space	Horse Power
8 Engine lathes 14″×6′ 0″	2′ 0″× 7′ 0″	1½ each
4 Engine lathes 16″×6′ 0″	2′ 0″× 7′ 0″	1½ each
3 Engine lathes 18″×8′ 0″	2′ 0″× 9′ 0″	2 each
1 Engine lathe 24″×12′ 0″	2′ 6″×12′ 0″	4
1 Tool-makers' lathe 14″×6′ 0″	2′ 0″× 7′ 0″	1½
1 Tool-makers' lathe 16″×6′ 0″	2′ 0″× 7′ 0″	1½
1 Small tool-makers' bench lathe	1′ 6″× 5′ 0″	1
1 Speed lathe 12″×5′ 0″	2′ 0″× 5′ 6″	1
1 Large milling machine	7′ 0″× 9′ 0″	5
1 Universal milling machine	2′ 4″× 4′ 7″	2
1 Large universal grinder	5′ 0″× 6′ 0″	2
1 Small universal grinder (for tool room)	3′ 0″× 4′ 0″	¾
1 30″ Radial drill	6′ 4″× 7′ 0″	3
1 22″ Back-geared drill press	3′ 0″× 4′ 0″	2
1 Sensitive drill press	2′ 0″× 2′ 0″	½
1 Wet emery grinder	1′ 6″× 2′ 6″	2
1 Dry emery grinder	1′ 6″× 2′ 6″	2
1 Planer 30″×30″×10′ 0″	5′ 0″×16′ 0″	5
1 Power hack saw	2′ 0″× 3′ 6″	½
1 16″ Shaper	2′ 6″× 4′ 10″	3
1 Gas hardening furnace	2′ 0″× 3′ 0″	
1 Brazing outfit with stand	3′ 0″× 3′ 0″	
1 Air pump for brazing and hardening furnace	1′ 0″× 2′ 0″	2
1 Acetylene welding outfit	Portable	

Other machines might be added, but the above list gives a very satisfactory equipment for a general machine-shop course. Two or three of the lathes should be fitted with taper attachments, and at least one with a relieving attachment, and each should have one universal three-jawed and one independent four-jawed chuck. Part of the lathes should be belt-driven and part motor-driven; there should also be several different makes of lathes, so as to familiarize students with various types.

A large assortment of tools should be kept in the tool room, such as milling cutters of various kinds, mandrels, taps and dies, reamers, drills, lathe dogs, clamps, planer jacks, standard gauges, scales, dividers, surface gauges, vernier and micrometer calipers, tool holders, etc., etc. If much tool and gear hardening are to be done a pyroscope or pyrometer and a sclereoscope are very desirable. A convenient form of tool-room cabinet is shown in Figure 375. A useful tool stand to be placed beside each lathe is shown in Figure 376. Figure 377 shows a handy device for caring for chucks and face plates. It is fastened to the floor at the head of the lathe.

The tool room is perhaps a more important adjunct in the machine shop than in any of the other shops. It should be centrally located so as to be reached by students from all parts of the shop without too much traveling. It should be well lighted and provided with a few machines such as tool makers' lathe and universal tool and cutter grinder for use of the tool-room attendant in making and repairing tools.

The Foundry (Figure 378). — A reference to the main floor plan of the shop building group, Figure 367, shows

Fig. 376. — Tool Stand.

that the foundry in this design is a wider building than any other except the automobile shop. The floor space is divided into three areas running lengthwise of the shop. The roof over the central portion is higher than that over the two side portions. This allows height for operating a traveling crane. The crane as well as the clerestory is supported by the two rows of columns shown. The height of the walls of the other buildings is fourteen feet from the floor to the under side of the roof trusses. This does not give room to operate a traveling crane; therefore, instead of making the whole building higher, the central portion only is raised, allowing a crane of shorter span to be installed. The smaller crane is

less expensive to purchase and to operate, and will admit of lighter supports. The span of the crane that would be installed in this shop is twenty-four feet. This is sufficient space for all heavy floor molding or work requiring the use of a crane. The side areas can be used for bench molding or light floor molding.

A smaller shop might suffice for a school, but if a building the same width as the other shops in this plan, viz., forty-five feet, is built, it is almost too narrow to divide into three areas as above, and if this is not done, and a crane is installed, it would have to be of forty-five foot span. Such a crane would require a heavy bridge, larger motors to operate it, and stronger supports to carry it, all of which increases the expense.

It is not necessary that the crane should operate over the entire area of the foundry, therefore the plan suggested in Figure 378 is the best where a traveling crane is desired. If a small building is built for a foundry, then probably no crane or only a jib crane should be put in.

The school foundry crane should be a two-ton, three-motor crane, operated from the floor. One motor is to drive the mechanism which propels the bridge from end to end of the building, the second motor moves the crane from end to end of the bridge, and the third operates the hoist. Safety stops should be installed to prevent over travel either of bridge, crane, or hoist.

The floor of the foundry should have a depth of about two feet of molding sand, and in the central portion there should be a good-sized area excavated to a depth of four to six feet and filled with molding sand for pit molding.

The cupola should be placed at one end of the foundry, as shown, and within reach of the crane. A two-ton cupola is about thirty-six inches in diameter above the tuyeres. This size is ample for the school foundry. A fan or pressure blower with motor to drive it is needed to operate the cupola. They may be placed in any convenient position and piped to the cupola. Across this end of the building is the charging platform, from which the coke and iron are fed into the furnace. This platform is about 10 feet above the floor. The storeroom for coke and iron should be located as close to the cupola as possible, to avoid unnecessary time and labor in handling. The storeroom in the plan (Figure 378) is shown directly back of the cupola, so that the coke and iron need be moved but a few feet and picked up by the crane and lifted on to the charging platform.

The core making may be carried on in the main room of the foundry, but it is preferable to have it in a separate room as shown. Ample bench room should be provided, also floor space for keeping core sand and other materials. A moderate-sized core oven with the necessary smokestack should be installed in this room. A metal truck which can be wheeled into the oven should be provided for handling large cores.

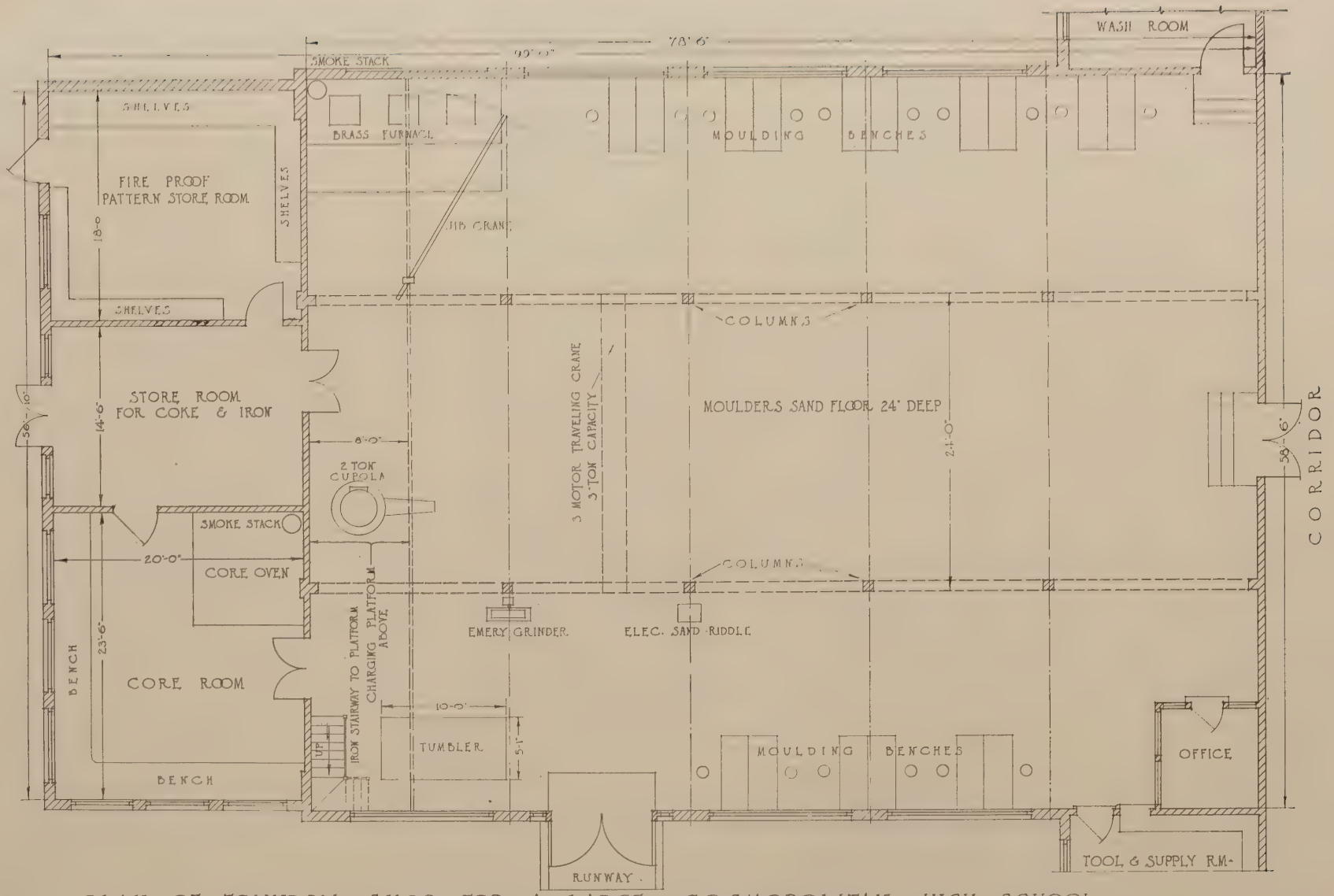
There should be a room in which patterns may be stored in an orderly manner and protected from injury.

The school foundry should provide facilities for making castings of brass, bronze, aluminum, and other of the softer metals. The brass furnace may be placed in any convenient part of the foundry, preferably near the supply of fuel and metals. The one shown in the plan is practically three furnaces combined, so that three crucibles can be operated at once.

FIG. 377. — CHUCK RACK.

Various types of brass furnaces are in use, some burning oil, others burning coke. A simple form of furnace to construct is that shown in the plan. It is built of brick with iron grate and top, and is lined with fire brick. The flues from the three fire pots lead into the same smokestack. Coke is used in this furnace, and it may be operated either with or without forced draft. The furnace is sunk into the ground, the top being only eight or ten inches above the floor. As the furnace is out of reach of the large traveling crane, a jib crane may be installed within convenient reach.

Along the sides of the building are placed benches



PLAN OF FOUNDRY SHOP FOR A LARGE COSMOPOLITAN HIGH SCHOOL

SCALE 0 5 10 15

WALTER A. TENNEY · VOCATIONAL DIRECTOR
JOHN J. DONOVAN · ARCHITECT · } COLLABORATORS.
OAKLAND · CALIFORNIA MARCH 26. 1919.

FIG. 378.

Messrs. Perkins, Fellows & Hamilton, Architects.

FIG. 379. — FOUNDRY, NEW TRIER TOWNSHIP HIGH SCHOOL, KENILWORTH, ILLINOIS.

upon which light molding can be done. These molding benches are sometimes built in the form of bins in which some special or fine grade of molding sand is kept. They are 4′ 6″ wide, by 6′ 0″ long, and are double so that a student may work from either side.

Other stationary equipment needed for the foundry is:

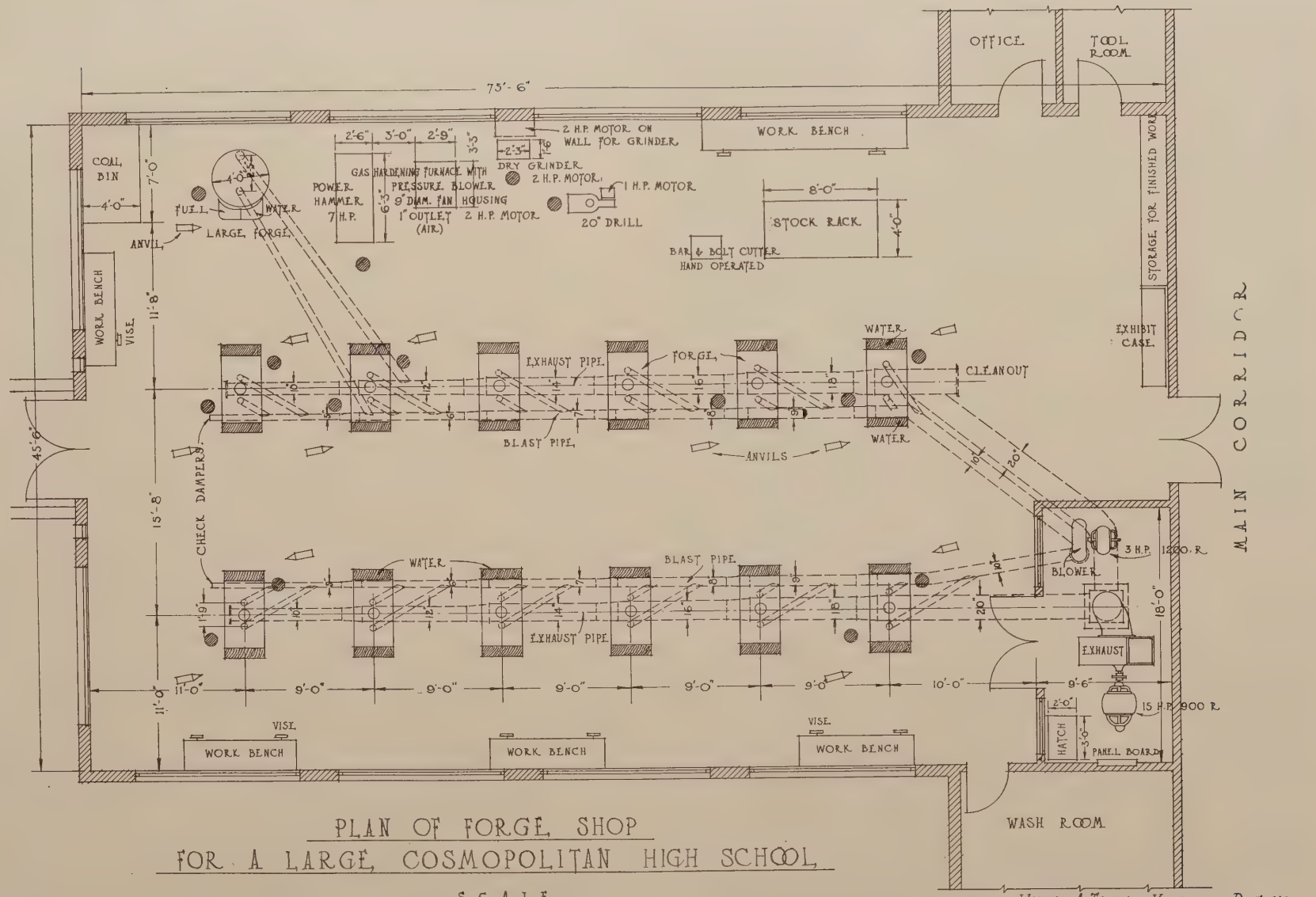
MACHINE	FLOOR SPACE	HORSE POWER
1 Core-wire straightener	2′ 0″×2′ 0″	1½
1 Tumbling barrel with motor	4′ 5″×8′ 6″	2
1 Electric sand riddle	4′ 0″×4′ 0″	½
1 Emery grinder with motor	1′ 6″×2′ 4″	2

Each student should be provided with a molder's tool box and an assortment of molder's trowels, slicks, and other tools for finishing molds, lifters, gate cutters, swabs and swab dishes, parting sand dishes and dusters, shovels, riddles, bellows, molder's brushes, and camel's-hair brushes, etc.

There should be an assortment of large ladles with swivel shanks, also small hand ladles with shanks, snap flasks and weights of various sizes, flask clamps, clamp bars, wheelbarrows for coke and iron, a thousand-pound scrap-iron scale, crucibles, and other tools and appliances. Wooden molder's flasks of all sizes should be made as needed in the woodworking shop.

The Forge Shop (Figure 380). — The floor plan here shown and the photograph (Figure 381) illustrate the proper arrangement of equipment in the forge shop, two rows of double forges running lengthwise of the room, with ample working space between them, benches containing the blacksmiths' vises against the wall, and the power hammer and other machines conveniently grouped at one side. The shop shown in the photograph has a concrete floor.

The kind of floor that should be laid in the forge shop is a question requiring careful study. The earth or cinder floor is safe, from the standpoint of fire risk, and while it is soft to stand upon, it is ruinous to the shoes, and the black dust constantly arising from the floor makes it impossible for the students to keep either their persons or clothing clean. If the floor is sprinkled to keep the dust down, it is just as hard on the shoes, and standing on the wet floor is a menace to health, especially in cold weather. The concrete floor is safe from fire, but is hard to stand on. The wooden floor is more comfortable to the feet, but offers more danger from fire. In a fireproof building the wooden floor on top of a concrete floor offers less fire risk, and more comfort. In a wooden building it is a question between fire risk and comfort; one must be sacrificed to obtain the other.



PLAN OF FORGE SHOP
FOR A LARGE COSMOPOLITAN HIGH SCHOOL

SCALE
0' 5' 10' 15'

NOTE: ● INDICATES POSITION OF THE STUDENT.

WALTER A. TENNEY - VOCATIONAL DIRECTOR.
& JOHN J. DONOVAN - ARCHITECT.
414 - 13TH STREET - OAKLAND - CAL.

FEB. 18 - 1919.

FIG. 380.

FIG. 381. — FORGE SHOP, OAKLAND TECHNICAL HIGH SCHOOL, OAKLAND, CALIFORNIA.

Mr. John J. Donovan, Architect.

If a wooden floor is laid, it may be of surfaced 2″ plank, overlaid with $\frac{7}{8}$″ tongue and groove flooring, so the surface can be relaid from time to time as it becomes worn and splintered. A more satisfactory wooden floor is made of redwood blocks laid with the wood fiber on

Fig. 382. — Forge Shop.

end, with a foundation of concrete or closely laid, seasoned and sized boards, well nailed to joist.

The machine equipment for the forge shop should be:

Machine or Apparatus	Floor Space	Horse Power
24 Forges in pairs	2′ 10″×6′ 3″	
24 Anvils — 125-lb.	1′ 3″×2′ 0″	
1 Large forge	4′ 0″×4′ 10″	
1 Large anvil — 250-lb.	1′ 4″×2′ 6″	
1 Power hammer	2′ 6″×6′ 3″	$7\frac{1}{2}$
1 Drill press — 22″ back geared	3′ 0″×4′ 0″	2
1 Dry emery grinder 12″ to 14″	1′ 6″×2′ 6″	2
1 Gas hardening furnace	2′ 9″×3′ 3″	
1 Air pump for furnace	1′ 0″×2′ 0″	2
1 Blower for forges	1′ 6″×3′ 6″	$7\frac{1}{2}$
1 Exhauster for forges	5′ 3″×5′ 3″	15
1 Bar and bolt cutter	1′ 6″×2′ 0″	Hand

With each forge should be a set of the following tools:

2 Set hammers (one large, one small).
1 Hand hammer.
1 Sledge, 5-lb.
1 Sledge, 10-lb.
1 Set flat tongs from $\frac{1}{4}$″ to 1″.
1 Set square bit tongs $\frac{3}{8}$″ to $1\frac{1}{2}$″.
1 Pair chisel tongs for eye chisels.
2 Pair tongs for hand chisels.
3 Pair chain tongs.
1 Hardie.
4 Hot eye chisels.
2 Cold eye chisels.
1 Eye center punch.
1 Poker.
1 Small shovel.
Hand punches to suit the work.
1 Large flatter 3″ face.
1 Round edge flatter 2″×$1\frac{1}{2}$″ face.

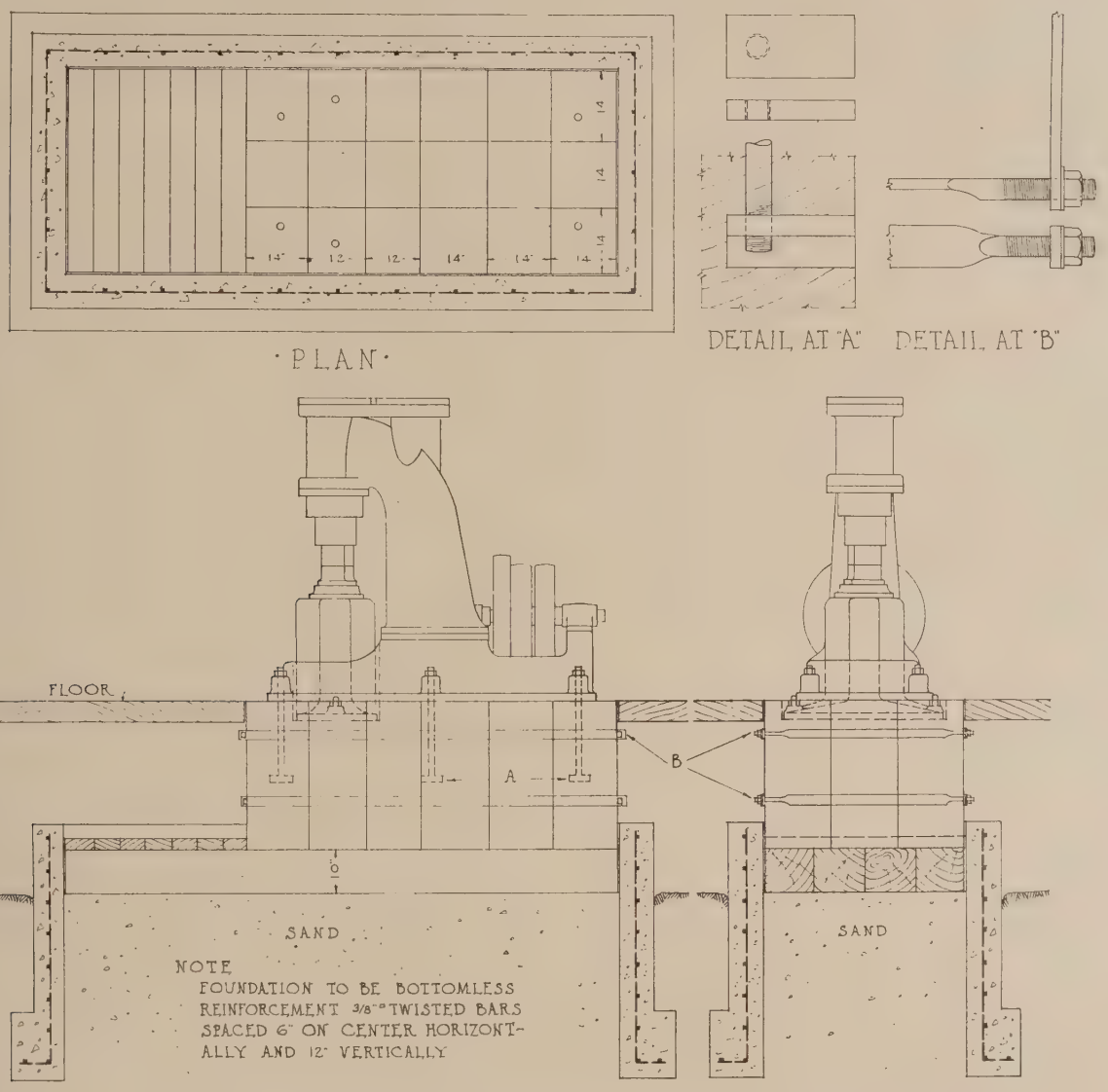
The following tools should be provided, and kept in racks conveniently placed, for the use of all the students in common:

2 Sets top swages from $\frac{1}{4}$″ to $1\frac{1}{2}$″.
2 Sets bottom swages from $\frac{1}{4}$″ to 1″.
2 Sets top fullers from $\frac{1}{4}$″ to 1″.
2 Sets bottom fullers from $\frac{1}{4}$″ to 1″.
2 Eye punches (one large and one small).
1 Set round punches from $\frac{1}{4}$″ to 1″.
1 Set heading tools from $\frac{1}{4}$″ to 1″.
1 Swage block.
1 Coal shovel.
1 Water bucket.

The cast iron anvil base shown in Figure 381 is found more satisfactory than the wooden blocks frequently used, provided the forge shop has a very rigid floor.

Several work benches should be placed in convenient positions with the blacksmiths' vises on them. Six or eight vises will be ample for the class. Work benches should be against the wall and about two feet to two feet six inches in width. The length may vary to suit conditions in the shop.

If the blower and exhauster listed above are provided with direct connected motors, they will require floor space about 3′ 6″×3′ 6″ and 5′ 3″×10′ 0″ respectively. If twenty-five forges are installed, a blower with about a 32″ fan run at 1200 revolutions per minute, outlet about $11\frac{3}{4}$″ diameter, will furnish the necessary blast and require about $7\frac{1}{2}$ horse power. If the down draft system is used a steel plate exhauster with 50″ fan at 900 R. P. M., 24″ inlet, will supply the draft and require about 15 horse power. The fans may be run at higher speed and correspondingly reduced in size and horse power. If



FOUNDATION FOR A POWER HAMMER

NO SCALE

WALTER A. TENNEY, VOCATIONAL DIRECTOR
JOHN J. DONOVAN, ARCHITECT
OAKLAND CALIFORNIA

} COLLABORATORS

FIG. 383.

the overhead exhaust system is used, a fan of much smaller capacity will serve, and if the smoke pipes extend from the hoods straight up through the roof the exhaust fan may be omitted altogether. The plan shows the fans for the forge blast and exhaust systems in a small separate room. This is preferable though not imperative.

The sizes and arrangement of piping for the forge blast and exhaust are shown in Figure 380. The piping may be galvanized iron or drain pipe. If the forge shop floor is from three to five feet above the ground, iron pipe may be used and hung to the under side of the floor. If the floor is of earth or cinders, or of concrete and laid on the ground, then the pipe must be laid underground. If the piping is laid underground, it may be drain pipe, with joints thoroughly cemented, or it may be sheet metal bedded in concrete. Even if drain pipe is used it is better to bed it in concrete, as the settling of the earth is liable to crack the joints, and in rainy weather, if water soaks into the ground where the pipe is laid, it will fill the pipe and render it useless until it is pumped out. The concrete should be 4″ thick around the pipe on all sides.

If down draft forges are installed a double forge is recommended. They make a neat looking installation and save somewhat in floor space and in piping. The double forge requires a floor space 34″×75″ and should be placed eight or nine feet from center to center measured lengthwise of the rows as shown in Figure 380, leaving five or six feet clear working space between. When the forges are placed in two rows the center lines of the two rows should be about sixteen feet apart so as to leave ample room for a student using a sledge to swing it without interference.

The forge shown in Figure 382 was designed by Mr. Frank Weaver, instructor in forge work in the Vocational High School, Oakland, California, and built by the students. This forge is not the down draft type. It has the mechanical blast and overhead exhaust. It may be used either with or without the exhaust fan. If in a one-story building, the exhaust pipe from each group of forges may be carried directly through the roof, and the natural draft will be found satisfactory without the fan. The exhaust pipe has a telescope joint, and the hoods are counterweighted so they can be raised or lowered. The cut shows a group of four forges built together. In this way they economize in floor space and in piping, are compact and neat in appearance, and easy to keep clean. The tuyeres are self-cleaning, by simply removing the cap on the pipe extending through the side of the forge and turning on the blast. Each group of four forges requires a floor space six feet by six feet and should have a clear space between groups of from four to five feet.

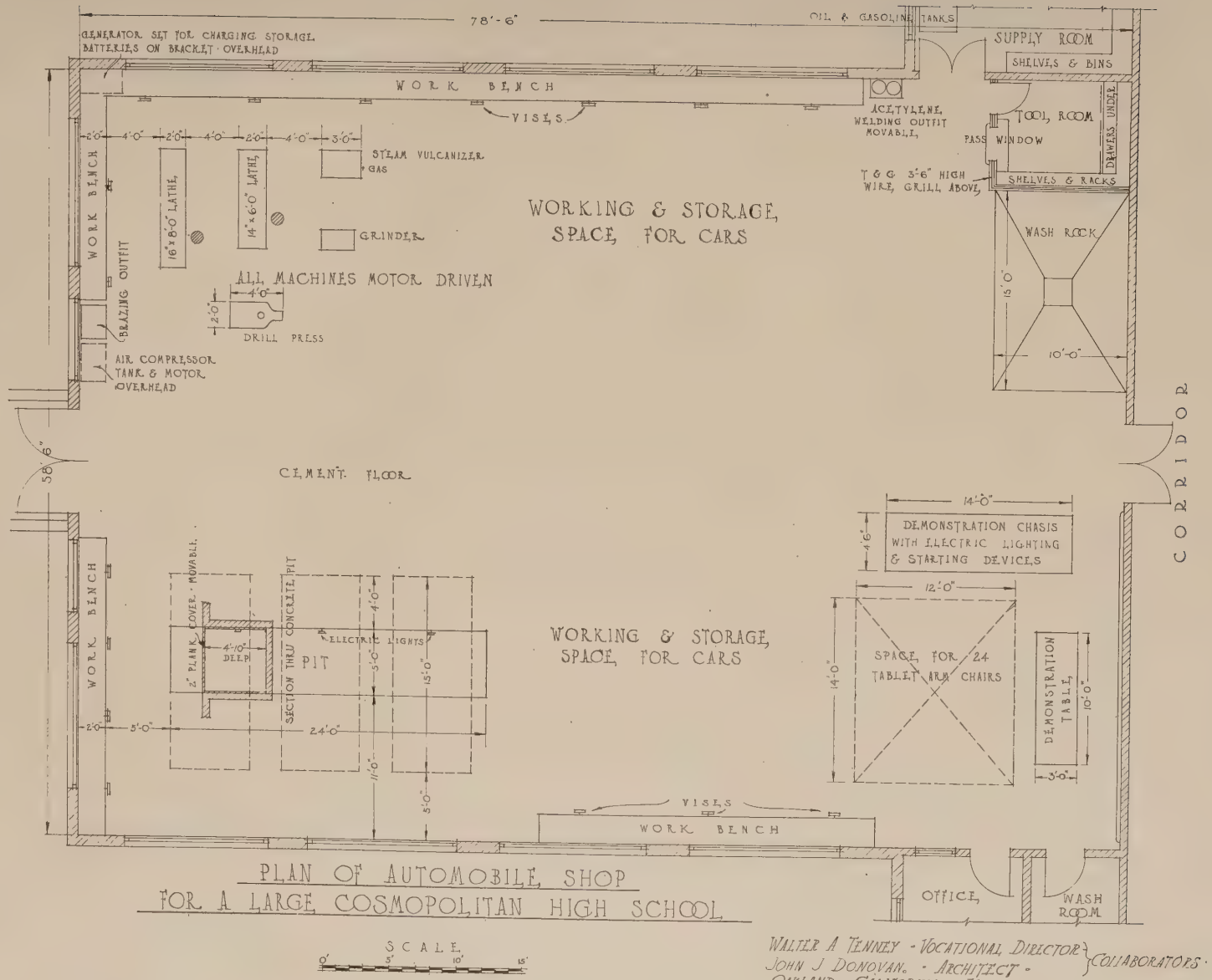
These forges are the result of years of experience on the part of the designer both in commercial shops and in teaching, and are the most satisfactory of all the forges known to the writer. They are so simple that they can be built by the students of any manual training high school, as very few tools are needed in their construction.

The large forge shown in Figure 380 near the power hammer is four feet in diameter, and the water and coal tanks extend 10″, making the total floor space 48″×58″. A single forge of the type shown in Figure 382 may be substituted.

There are several types of power hammers in use. For a well-equipped high school shop, a hammer that will work stock about four inches thick is preferable, though smaller sizes are frequently installed. A belt-driven trip hammer, that will work stock up to three and a half inches in thickness, requires a floor space 36″×51″, also belting, pulleys, shafting, and some source of power. It is also furnished with individual motor. A self-contained power hammer operated by compressed air generated in the machine itself has been found very satisfactory. This hammer is furnished for either belt or individual motor drive. It requires floor space 2′ 6″ × 6′ 3″ and $7\frac{1}{2}$ horse power. A genuine steam hammer can only be installed if the school has a high pressure steam power plant in constant operation. A steam hammer may be operated by compressed air. This will require an air compressor, tank, and motor or other source of power. The floor space occupied by the machine is 2′ $10\frac{1}{2}$″×1′ 9″, and the tank, compressor, and motor will require about 4′ 0″×12′ 0″. These latter may be placed overhead, upon a raised platform or gallery.

A power hammer must have a special foundation. There are several ways of building it. One method is to make a solid concrete block considerably larger than the base of the hammer, set into the ground from one to three feet, depending on the height of the shop floor above ground. Pipes containing anchor bolts must be placed (so that the location of the bolts will coincide with the holes in the base of the machine) before the concrete is poured. Under the anvil the top surface of the concrete must be about eight inches lower than the general surface, so that a cushion of wood may be interposed.

A better method (Figure 383) is to build a bottomless reinforced concrete box, sunk into the ground three feet or more, depending on the height of the shop floor above ground. The box should be filled to a depth of two or three feet with sand. On top of the sand, laid lengthwise of the box, are timbers of soft wood that will withstand decay. They should be eight or ten inches thick and should fill the box from end to end and from



PLAN OF AUTOMOBILE SHOP
FOR A LARGE COSMOPOLITAN HIGH SCHOOL

SCALE 0' 5' 10' 15'

WALTER A TENNEY - VOCATIONAL DIRECTOR
JOHN J DONOVAN. - ARCHITECT - } COLLABORATORS.
OAKLAND - CALIFORNIA - FEBRUARY 18 1919.

FIG. 384.

side to side. On top of these are timbers 12″ or 14″ square stood on end, the top ends on a level with the top surface of the floor. The upright timbers should be bound together with iron bands and the machine bolted on as shown. The top surface of the timber foundation should be about three inches or four inches larger on all sides than the base of the machine, and the center of the anvil should be over the center of the sand box.

Gas tool-hardening and tempering furnaces may be obtained in various sizes. A size that will be adequate for any work likely to be done in the school shop will occupy a floor space 2′ 9″×3′ 3″. It will require piping for gas and air, and an air pump either motor or belt-driven. The best arrangement is a rotary air pump with direct connected motor mounted on the same base, which may be placed in any out-of-the-way position, as overhead, or on a bracket on the wall, thus occupying no floor space otherwise needed. An air pump with 1″ outlet and 2 horse power motor will be adequate.

A dry emery grinder carrying two wheels about 2″×14″ and mounted on an iron column will require about 1′ 6″×2′ 3″ floor space and a two horse power to run it. If an individual motor is used, a two horse power 1800 R. P. M. motor placed overhead and belted direct to the grinder will be satisfactory.

A combination punch and shear, while not an absolute necessity, is a great convenience to the forge shop. A machine that will punch holes up to $\frac{1}{2}$″ diameter in $\frac{1}{2}$″ stock and cut rounds 1″ diameter and flats 3″×$\frac{5}{8}$″ is recommended. It will require a 2 feet by 3 feet floor space and is hand operated.

If a central storeroom is not maintained in the school plant, in which supplies for all shops are stored to be issued as the instructor needs them, then a stock rack to carry bars of iron and steel will be needed in the forge shop itself. An adequate rack will occupy floor space 4′ 0″× 8′ 0″. A coal bin must be provided, in or adjoining the shop, large enough to contain two or three tons of coal.

The Automobile Shop (Figure 384). — The drawing shows a shop about sixty by eighty feet. A smaller shop could be made to render good service, but would not be quite satisfactory. The writer has operated a school automobile shop fifty by sixty feet, in which practical repair work has been carried on continuously with considerable success; but it was found, that with a class of fifteen to twenty students, there was insufficient room, and the efficiency was reduced on this account.

This shop should have a concrete floor, and should be as near fireproof as possible on account of the danger from oils and gasoline. There should be ample floor space so that a number of cars, say twelve or fifteen, can be taken into the shop at one time.

There should be a pit five feet wide, five feet deep, and twenty-four feet long conveniently located. A good plan is to have it about eleven feet from one wall, leaving room to pass around the end of a car when over the pit, and also within easy access of the machines and the tool room. A pit of the above dimensions will accommodate three cars at one time. The pit should have a cover of two inch planks, ten or twelve inches wide, set flush with the floor. The planks should all be separate from each other, and should fit closely so when they are all in place the pit is completely covered, and each should have a rope handle by which to lift it. There should be about three electric light outlets in the side wall of the pit, into which to plug light-cords, which will reach to any part of a machine which the workman desires to get at while in the pit.

Another plan, and one which is in some ways preferable, is to have a raised platform about five feet above the floor, upon which the car can be placed while working underneath it. The platform is more convenient for the workman but requires more room, because of the space occupied by the incline upon which the car must be taken up and down.

A small fireproof storeroom should be built at one side of the automobile shop in which to keep oils, greases, and gasoline. It is advisable to purchase oils in barrel lots. If this is done they may be kept in the barrels, in which case a rack will be needed on which to set the barrels, elevating them sufficiently above the floor for convenience in drawing oil. A better way is to have metal tanks into which the oil may be transferred from the barrels in which it is received. In either case the door to this storeroom should be large enough for a barrel to be taken in and out easily. The larger supplies might also be kept in this room.

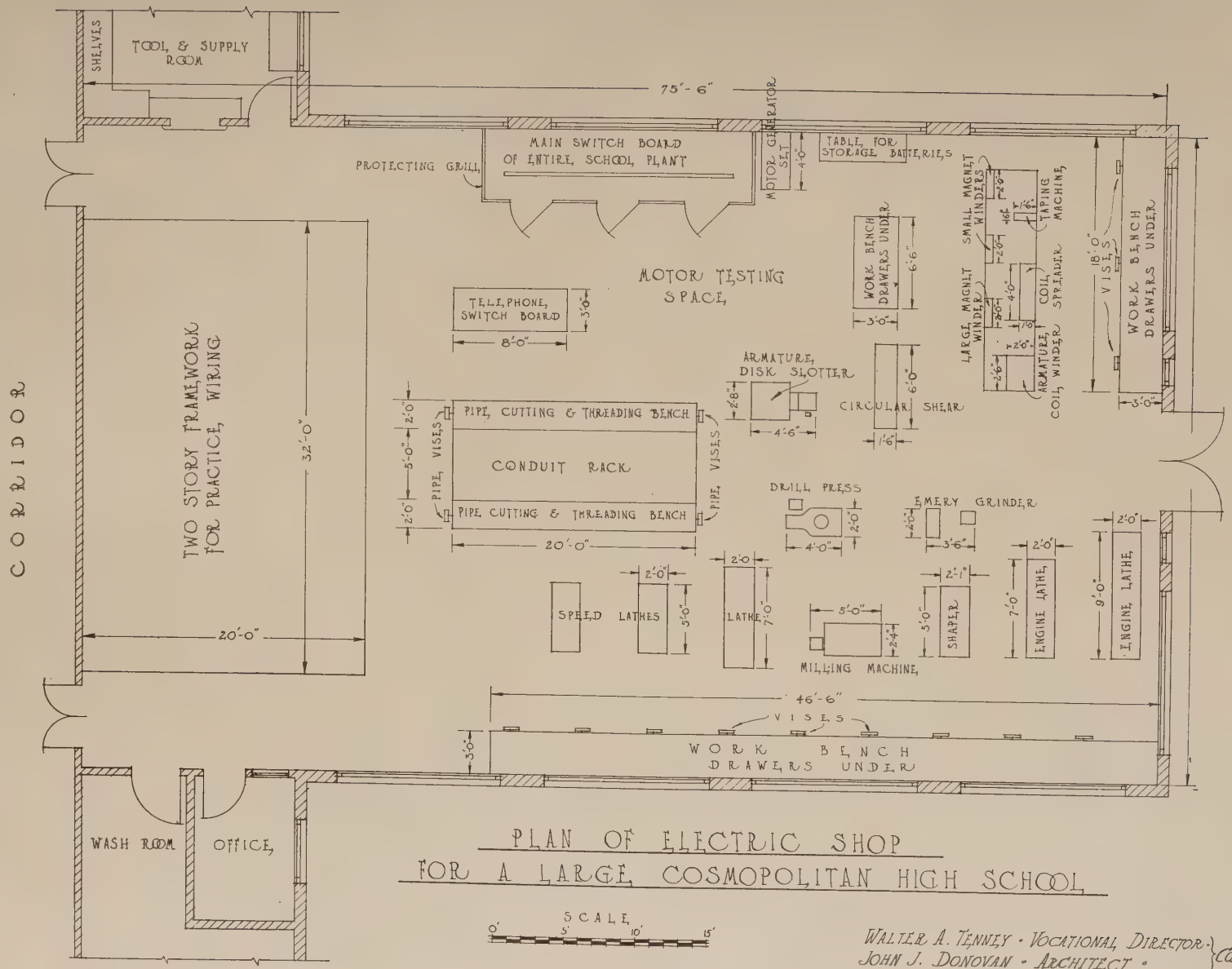
There should also be a small room, fitted with drawers and shelves, for tools and small supplies, and also an office for the instructor.

It is sometimes desirable to lift one end of a car from the floor and support it without putting jacks underneath. For this purpose it is convenient to have a one or two ton differential chain hoist attached to one of the roof trusses. Care should be taken to insure that the truss is strong enough to sustain the additional load.

The list of equipment on page 449 includes the most essential items that should be found in the school shop.

The garage press and the portable crane may be built by any school having a machine and forge shop.

If the school has a separate electric shop, the charging of storage batteries may be done there, and the generator set omitted from the automobile shop equipment. If



PLAN OF ELECTRIC SHOP FOR A LARGE COSMOPOLITAN HIGH SCHOOL

WALTER A. TENNEY · VOCATIONAL DIRECTOR
JOHN J. DONOVAN · ARCHITECT
} COLLABORATORS
OAKLAND · CALIFORNIA · APRIL · 3 · 1919 ·

FIG. 385.

Mr. Floyd A. Naramore, Architect.

FIG. 386. — BENSON POLYTECHNIC HIGH SCHOOL ELECTRICAL SHOP, PORTLAND, OREGON.

Mr. Floyd A. Naramore, Architect.

FIG. 387. — ELECTRICAL SHOP, BENSON POLYTECHNIC HIGH SCHOOL, PORTLAND, OREGON.

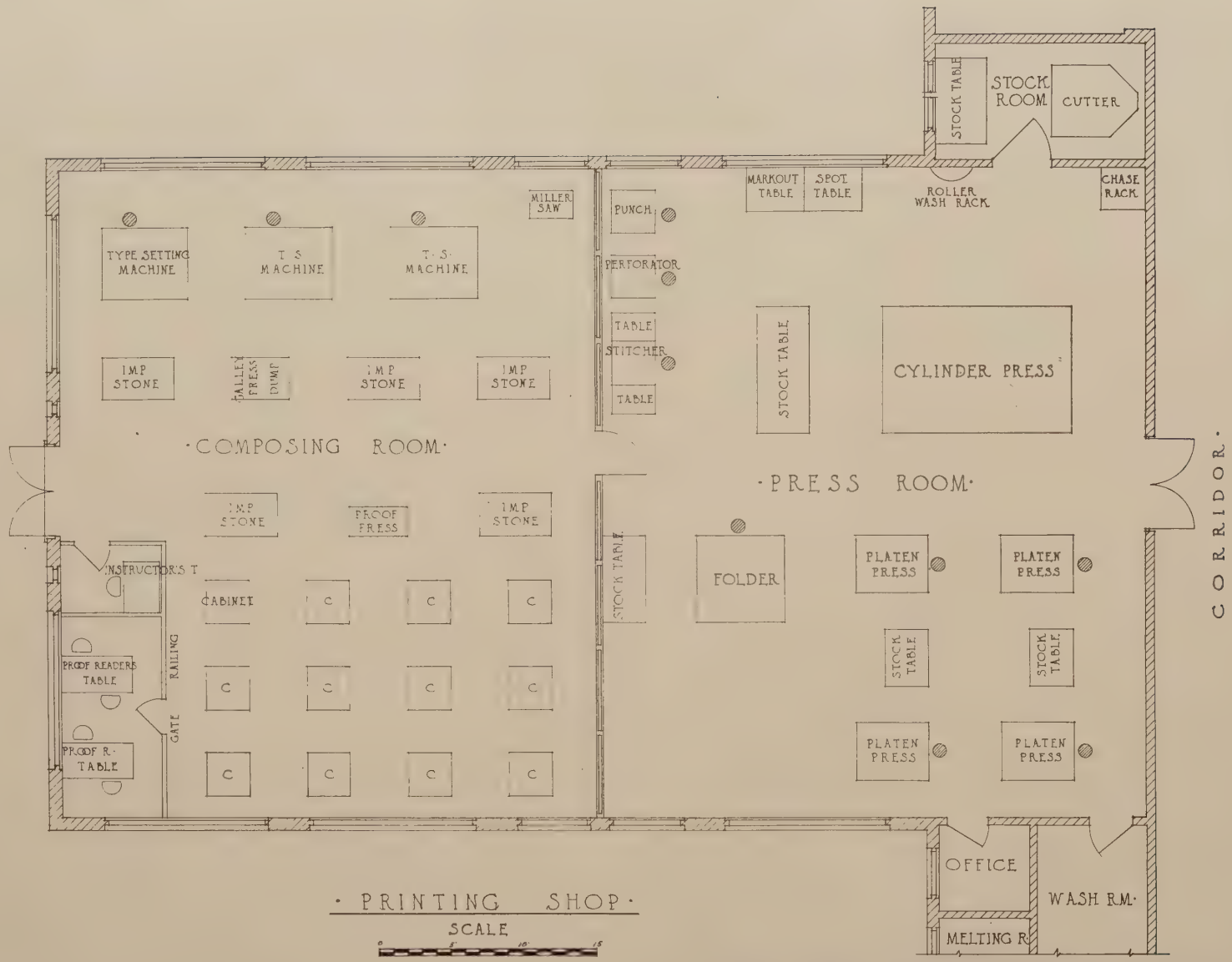
	FLOOR SPACE	HORSE POWER		FLOOR SPACE	HORSE POWER
1 Garage press	3′ 0″×3′ 0″	Hand	1 Electric drill	Portable	$\frac{1}{6}$
1 Electric generator for storage batteries	2′ 0″×3′ 6″	5	1 Electric auto starter	7′ 0″×5′ 0″	2
1 Air compressor and tank	3′ 0″×4′ 0″	3	1 Electric valve grinder	Portable	$\frac{1}{8}$
1 Steam vulcanizing outfit	2′ 0″×3′ 0″		1 Portable three-wheel jack		
1 2″×12″ Two-wheel emery grinder	1′ 6″×2′ 3″	2	8 Auto jacks		
1 14″×6′ 0″ Engine lathe	2′ 0″×7′ 0″	2	15 Machinists' vises		
1 16″×8′ 0″ Engine lathe	2′ 0″×9′ 0″	2	15 Machinists' hammers		
1 20″ Back-geared drill press	2′ 0″×4′ 0″	1	1 Gas soldering furnace		
1 One- to two-ton differential chain hoist, attached to roof truss			3 Assorted sizes soldering coppers		
			1 Grease gun		
1 Portable crane with differential chain hoist			4 Sets solid open-end wrenches $\frac{1}{4}$″ to $\frac{3}{4}$″		
			1 Complete set "Ford" wrenches		
1 Brazing outfit	2′ 6″×2′ 6″		3 Assorted sizes monkey wrenches		
1 Acetylene welding outfit	Portable		3 Pyrene fire extinguishers		
1 Electric welding outfit	2′ 0″×4′ 0″	5	15 Screwdrivers, assorted sizes		

installed in the auto shop it may be placed on a platform overhead or on a bracket on the wall so as to take no floor space. The same is true of the air compressor and tank.

If a very extensive equipment is desired, more machines might be added. If no separate forge shop is maintained, at least one forge and anvil with set of tools should be installed in the auto shop, but if separate forge and machine shops are maintained, then the above makes a very good working equipment.

The machines should be grouped together in one part of the shop where there is good light and out of the way of cars passing in and out.

The Electrical Shop (Figure 385). — Where but one room can be given to electrical work, it should be large



WALTER A. TENNEY VOCATIONAL DIRECTOR
JOHN J. DONOVAN · ARCHITECT · } COLLABORATORS
OAKLAND · CALIFORNIA ·

FIG. 388.

enough, and the equipment should be selected and arranged with a view to giving instruction in house wiring, telephone work, switchboard work, and construction and repair of electrical machines and appliances. Such an arrangement is shown in the plan.

To provide instruction in house wiring, a framework divided into three or four rooms should be built against one side or end of the shop, where it will cut off the least light. It should be built of full-sized framing lumber and put together in the same manner as a real building is constructed. It may be two stories in height. The students will use this for continuous practice in both knob and tube and conduit wiring, putting in and taking out again different wiring arrangements. When, through cutting and boring holes, parts of the framework become unfit for further use, they will be removed and replaced by new pieces.

It is a very good plan to make the electric shop the main distribution point for all the electrical service for the entire school plant. This arrangement gives the electric shop a large practical working switchboard providing both direct and alternating current for the students to observe, care for, and study, which is a valuable piece of instructional apparatus, obtainable in no other way. The board should be guarded by an iron grillwork extending nearly or quite the full height of the board, and provided with doors at convenient intervals as indicated on the plan.

A rack for holding a quantity of iron conduit of different sizes, and up to twenty feet in length, may be placed in a convenient position in the shop. The one shown in the figure is in direct line with the outside doors, so the pipe can be brought straight into the rack without turning or carrying around or over machines or other equipment. Convenient to the rack should be benches containing pipe vises, where cutting and threading may be done. If the floor space is limited and a central storeroom is provided for the whole plant, the conduit rack may be omitted, and the conduit brought from the storeroom as needed for immediate use, or a limited quantity stored under the bench.

A telephone switchboard may be installed in any convenient position, from which lines may be run to telephones stationed in various places about the room.

Long work benches should be placed against the wall with large lock drawers built under them for pupils' use. Machinist vises should be fitted on these benches at about five or six foot intervals, also soldering stoves. A small gas pipe should be run along the wall at the back of the bench and the stoves permanently connected to it.

A table for storage batteries should be conveniently placed, preferably away from other equipment. If space allows it is better to arrange a separate room for storage-battery work. The generator, if the floor space is needed, may be placed on an overhead support which can easily be arranged.

In addition to the items above mentioned, the following will be found a very satisfactory list of equipment:

Machines	Floor Space	Horse Power
1 16″×8′ 0″ Engine lathe	2′ 0″×9′ 0″	2
2 14″×6′ 0″ Engine lathe	2′ 0″×7′ 0″	2 each
2 12″×4′ 0″ Speed lathe with draw in collets	2′ 0″×5′ 0″	1 each
1 Universal milling machine	2′ 0″×5′ 0″	3
1 Shaper	2′ 0″×5′ 0″	2
1 20″ Drill press, back geared	2′ 0″×4′ 0″	1
1 Emery grinder, two 2″×12″ wheels	1′ 6″×2′ 3″	2
1 Armature disk slotter	2′ 8″×4′ 6″	2
1 Circular shear	1′ 6″×6′ 0″	$\frac{3}{4}$
1 Armature coil winder	2′ 0″×2′ 6″	$\frac{3}{4}$
1 Armature coil spreader	1′ 0″×4′ 0″	Hand
1 Coil taping machine	1′ 0″×1′ 6″	$\frac{1}{4}$
1 Magnet winder for large magnets	1′ 0″×2′ 0″	$\frac{1}{4}$
2 Magnet winders for small magnets	1′ 0″×2′ 0″	$\frac{1}{6}$
1 5-k.w. generator set	2′ 0″×4′ 0″	$7\frac{1}{2}$

If no separate electrical laboratory is provided in the school, other generator sets of various types and sizes, also motors of various kinds, and one rotary converter should be installed in the electrical shop, for experimental purposes. It is better, however, to so arrange the work and equipment that the theoretical work and most of the electrical experiments can be performed in the electrical department of the science laboratory. The work in the electrical shop will then be almost wholly construction, repair, and practice in the operations and processes of the electrician's trade, and the equipment should be that which is necessary to carry out such a course.

A quantity of small tools must be provided, such as hack saws, pipe cutters and reamers, pipe dies, pipe wrenches, pliers, soldering coppers, drills, lathe tools, milling cutters, etc.

A tool room must be provided and fitted with shelves, drawers, racks, etc., for keeping the small tools.

The Printing Shop (Figure 388). — The shop and equipment shown in the plan will require, to handle the work properly, three instructors, a compositor to teach hand work and the fundamental principles and processes of the printing trade, a linotype operator to teach machine typesetting, and a pressman to teach presswork. This shop will accommodate thirty or more students at one time.

The equipment consists of:

FIG. 389. — PRINTING SHOP, JUNIOR HIGH SCHOOL, TRENTON, NEW JERSEY. *Mr. Wm. A. Poland, Architect.*

EQUIPMENT	FLOOR SPACE	HORSE POWER
12 Type cabinets	3′ 0″ × 3′ 0″	
4 Imposing tables with built-in units	3′ 0″ × 5′ 0″	
1 Imposing table with built-in units	4′ 0″ × 5′ 0″	
1 Proof press and stand	2′ 0″ × 4′ 0″	Hand
1 Galley press and stand	2′ 0″ × 4′ 0″	Hand
1 Miller saw	3′ 0″ × 3′ 0″	½
3 Typesetting machines, three-magazine type, with extra magazines and side magazine attachment	5′ 0″ × 6′ 0″	¾
1 Type dump	2′ 0″ × 3′ 0″	
1 Cylinder press 33″ × 46″ bed	8′ 9″ × 13′ 4″	5
1 Stock table for cylinder press with dry racks under	3′ 6″ × 8′ 9″	
4 10″ × 15″ Platen presses	4′ 0″ × 5′ 0″	¾ each
2 Stock tables with dry racks	3′ 0″ × 4′ 0″	
1 Folding machine	6′ 0″ × 6′ 0″	2
1 Stock table for folding machine	3′ 0″ × 6′ 0″	
1 Wire stitcher	3′ 0″ × 3′ 0″	⅙
1 Perforator	3′ 0″ × 3′ 0″	Foot
1 Punch	3′ 0″ × 3′ 0″	Foot
3 Tables for stitcher, punch and perforator	2′ 0″ × 3′ 0″	
1 Spot table	3′ 0″ × 4′ 0″	
1 Mark-out table	3′ 0″ × 4′ 0″	
1 30″ Paper cutter	5′ 0″ × 6′ 0″	1½
1 Table for cutter	3′ 6″ × 6′ 0″	
1 Chase rack	3′ 0″ × 3′ 0″	
1 Remelting furnace for type metal	3′ 0″ × 3′ 0″	
2 Proof readers' tables	2′ 8″ × 5′ 0″	

Also a large assortment of type of different sizes, styles, and faces; leads, slugs, rule, furniture, galleys, etc.

The stock room should be separate from the print shop and accessible from the outside, so the stock can be delivered without taking it through the shop.

Shelfing should be provided for storing stock in considerable quantities and of various sizes. It is desirable to have the paper cutter placed in the stock room if space will allow, also a stock table.

A small separate room should be built for the furnace used in remelting the type metal. A gas outlet must be provided for supplying fuel to the furnace, and a vent pipe similar to a stove pipe for carrying off the fumes. A supply of iron molds for casting the ingots of type metal will be needed in this room, also a ladle.

The space for proof reading and editorial work should either be partitioned off into a separate room or inclosed by a railing and provided with tables and chairs.

Good light is needed for nearly all the printing work but especially for typesetting. Therefore the type cases and typesetting machines are placed as near the windows as possible. They should also be equipped with electric lights. The typesetting machines must be supplied with electric current for the motors which operate them. The melting pots on these machines may be heated by either gas or electricity. The latter is more convenient both to install and to operate. If gas is used for heating,

a vent pipe, extending to the outside of the building, will be needed to carry off the fumes.

The cylinder press is a very heavy machine and in any but a very substantial and rigidly constructed building will cause vibrations, which will be very disturbing to the work in this department. If the printing shop is on the ground floor this difficulty may be overcome by building a separate foundation of concrete for the press. This foundation need not cover the entire area occupied by the press. Since the press rests upon the foundation along the two outer edges only, it may take the form of a hollow rectangle a little longer and wider than the base of the press. A section through one side of this rectangle would be about twelve or fourteen inches wide at the top and twenty or twenty-two inches at the bottom, and two or more feet high, depending on the height of the floor above the ground. Anchor bolts should be set in the concrete on the two long sides of the rectangle to hold in place two-inch planks placed on top of the concrete. The top surface of the planks should be level with the top surface of the floor. While the press rests only on the two long sides of the rectangle, the two short sides are necessary to tie them together. The central space may be filled with earth tamped down and covered with a three or four inch layer of concrete, making the top surface even with the floor.

Owing to the noise made by the presses it is an advantage to have the press and composing rooms separated by a comparatively soundproof partition.

In the plan a partition is shown, the upper part of which is double glass. A dead air space about four inches thick between the two thicknesses of glass helps to deaden the sound while admitting more light to the press room, and permitting a view of both rooms from either one of them, which is an advantage in supervision. The glass should be set in hinged sashes, so that both sides may be easily cleaned.

The school print shop will easily pay for itself by the output of work for the school system. The printing of school papers, a great variety of standard and special forms, reports, pamphlets and so forth both for the schools and the administrative offices will furnish valuable material for teaching purposes and also enable the print shop to become practically self-supporting, without taking in any commercial work from outside of the school system.

The Plumbing Shop (Figure 390). — The room and equipment here illustrated provide facilities for teaching the various branches of the plumbing trade in the modern high school.

On one side of the shop are five large double benches at which twenty to twenty-five students can work. These benches are provided with gas stoves and solder pots, and on the end of each bench is a pipe vise. There will be taught the fundamental principles and operations, such as cutting and threading small pipe by hand, making sheet lead seams; overcast and cup joints; wiping half inch, five-eighths inch, and two-inch round and branch joints, horizontal, upright, and vertical; wiping stopcock on lead pipe; flange joints; wiping small and large nipples to lead pipe; wiping two-inch and four-inch ferrules to lead pipe; wiping short bends with ferrules; half-S traps; S traps, etc., etc.

On the opposite side of the shop is shown the provision for instruction in setting up and connecting various plumbing fixtures. This consists of a framework divided into several rooms in which the students will practice installing sinks, lavatories, boilers, hot-water tanks, laundry trays, laundry stoves and heaters, urinals, closets, bath tubs, kitchen ranges, instantaneous water heaters, radiators, showers, gas fitting, and gas fixtures. This framework is two stories in height so as to give more space for students to work.

Another portion of the shop is devoted to practice in steam fitting, and still another to work on heavy soil and drain pipe, automatic cellar drainers, trapping and venting drain, soil and waste pipes, etc.

The equipment consists of:

Six Benches, 3′ 0″×16′ 0″.

One Pipe-threading machine, 1″ to 4″ pipe, Floor Space, 4′ 4″×7′ 0″, H. P., 3.

Individual sets of tools, comprising ladles, shave hooks, turn pins, bending pins, rasps, compasses, pliers, tap borers and dressers.

Equipment for general shop use comprises pipe cutters, pipe tongs and wrenches, pipe reamers, bending springs, calking irons, hammers, compass saws, blow torches, soldering coppers, levels, etc.

Pipe racks are provided for storing both long and short lengths of pipe of various sizes and kinds. This rack is placed so pipe can be unloaded into it directly from the delivery wagon outside. Bins for pipe fittings of all kinds are also provided.

Ventilating fans should be installed in this shop to carry off the lead fumes and keep the air pure.

The Sheet Metal Shop (Figure 392). — The plan shows an ideal arrangement for a sheet metal shop for instruction purposes. Long benches are provided against the walls under the windows, insuring good light. A gas pipe should be run along the back of these benches, to which are connected gas soldering stoves. There should be enough of these so that each student may have one. On these benches the preliminary work of the student, such as learning to solder, and practice work in laying out, cutting, and making various articles in sheet metal, will be done. Under these benches should be a set of

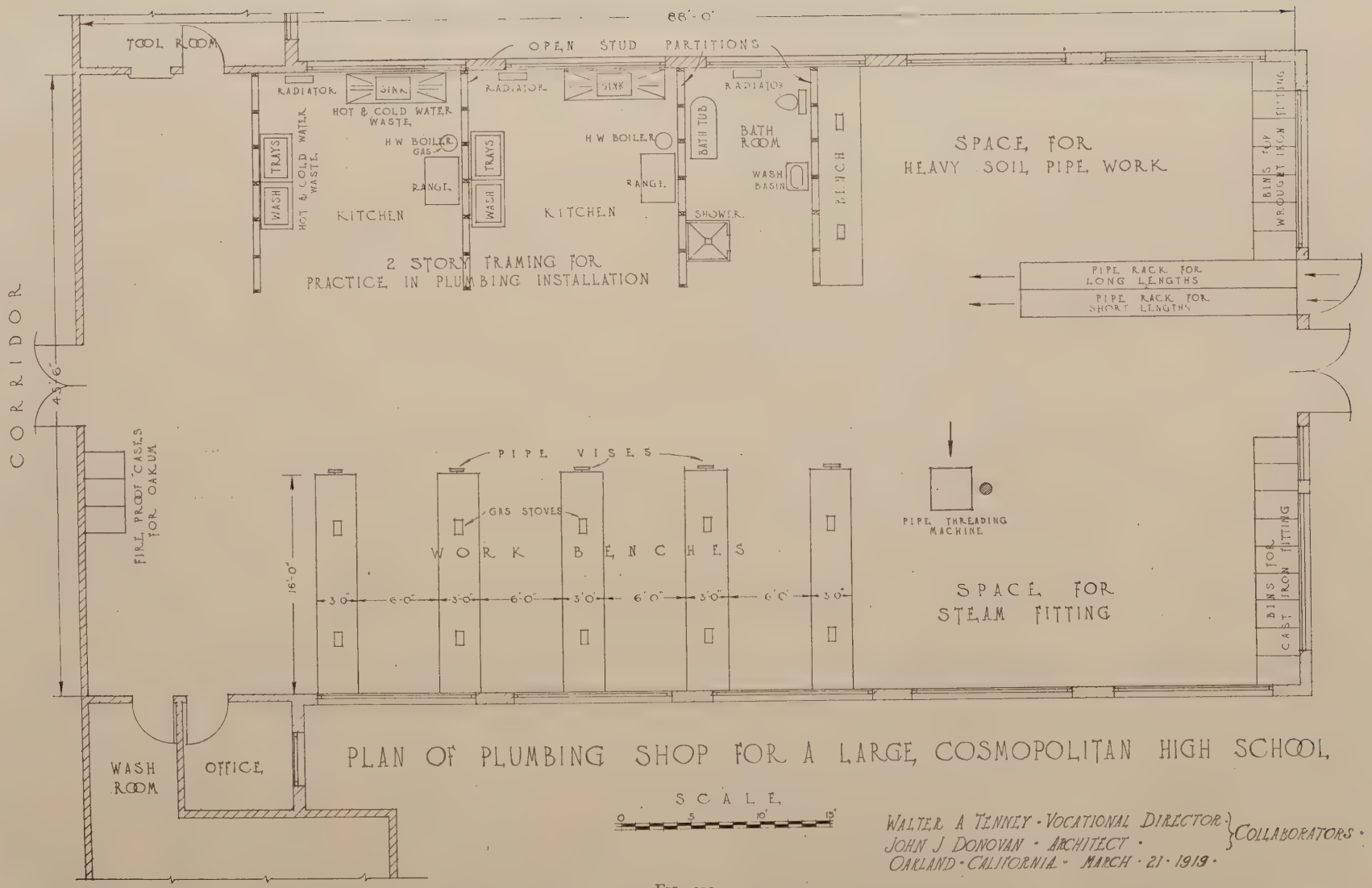

88'-0"
TOOL ROOM
OPEN STUD PARTITIONS
RADIATOR
SINK
HOT & COLD WATER WASTE
HW BOILER GAS
TRAYS
WASH
HOT & COLD WATER WASTE
RANGE
KITCHEN
KITCHEN
BATH TUB
BATH ROOM
WASH BASIN
SHOWER
BENCH
SPACE FOR HEAVY SOIL PIPE WORK
BINS FOR WROUGHT IRON FITTING
2 STORY FRAMING FOR PRACTICE IN PLUMBING INSTALLATION
PIPE RACK FOR LONG LENGTHS
PIPE RACK FOR SHORT LENGTHS
CORRIDOR
45'6"
FIRE PROOF CASES FOR OAKUM
PIPE VISES
GAS STOVES
WORK BENCHES
16'-0"
3'0" 6'0" 3'0" 6'0" 3'0" 6'0" 3'0" 6'0" 3'0"
PIPE THREADING MACHINE
SPACE FOR STEAM FITTING
BINS FOR CAST IRON FITTING
WASH ROOM
OFFICE
PLAN OF PLUMBING SHOP FOR A LARGE COSMOPOLITAN HIGH SCHOOL
SCALE
0 5 10' 15'
WALTER A TENNEY · VOCATIONAL DIRECTOR }
JOHN J DONOVAN · ARCHITECT · } COLLABORATORS ·
OAKLAND · CALIFORNIA · MARCH · 21 · 1919 ·

FIG. 390.

FIG. 391. — PLUMBING SHOP, BENSON POLYTECHNIC HIGH SCHOOL, PORTLAND, OREGON.

Mr. Floyd A. Naramore, Architect.

lock drawers, a separate drawer being provided for each student in which to keep his individual set of tools and small pieces of work.

Next to these benches on either side of the shop is a row of four large benches four by eight feet in size. On these benches will be placed the various hand machines and tools which will be used in cutting, forming, seaming, etc., such as rolls, turning, wiring, burring, grooving, beading, edging, crimping and seaming machines, and stakes of various kinds.

In the center of the room is one (or more) large table or bench on which to lay out large jobs, and ample floor space is left for erecting large pieces of work.

A storage rack for large sheets of metal is provided, conveniently placed at one end of the shop.

The equipment for this shop consists of:

One Hand punch, capacity No. 20 gauge iron.
One Squaring shear, 32″ to 40″.
One Ring and circular shear to cut 22″ circle.
One Folding machine, 20″.
One Combination brake and folder, 42″.
One Forming machine, slip roll pattern, 31″.
One Groover, 30″.
One Turning machine, capacity $\frac{3}{32}$″ to $\frac{1}{4}$″ wire.
One Wiring machine, capacity $\frac{3}{32}$″ to $\frac{5}{16}$″ wire.
One Burring machine, capacity $\frac{1}{4}$″.
One Setting down machine, capacity $\frac{3}{8}$″ seams.
One Elbow edging machine, No. 1 faces, $2\frac{1}{8}$″ rolls.
Extra pair No. 3 faces for above.
Extra pair No. 4 faces for above.
One Beading machine, $1\frac{5}{16}$″ rolls.
One Crimping machine, $1\frac{3}{4}$″.
One Seaming machine, capacity $15\frac{1}{2}$″.
One Samson punch.
One Mandrel stake, solid, $34\frac{1}{2}$″, hollow, 40″.
One Beakhorn stake, round end $16\frac{1}{2}$″, flat end 20″.
One Blowhorn stake, large end 9″, small end 18″.
One Double seaming stake, large end 17″, small end 12″.
One Needlecase stake, round end $10\frac{1}{2}$″, flat end 8″.
One Hatchet stake, length 13″.
One Hatchet stake, length 11″.
One Hatchet stake, length 9″.
One Bevel edge square stake, $2\frac{1}{2}$″ × $4\frac{1}{2}$″.
One Double seaming stake with 4 heads.
One Round head stake, $12\frac{1}{2}$″ long.
One Bench plate.
Two Pairs bench shears.
Twenty-two Gas furnaces, sheet iron top, brick lined.

The small machines listed above are all hand operated, and will be placed on the large work benches shown on the floor plan; therefore, as they will require no additional floor space, these sizes are not recorded in the list.

In the tool room, there should be an assortment of extra tools, such as snips, riveting hammers, setting hammers, raising hammers, cutting nippers, grooving tools, rivet sets, prick punches, solid punches, and hollow punches, all of various sizes, wire gauges, etc.

Each student should have a set of tools consisting of

One Mallet.
One Scratch awl.
One Rule.
One Pair snips.
One Two-pound soldering copper.
One Hammer.

A sheet metal shop equipped with up-to-date machines and tools for handling good-sized jobs can find a large amount of work in the school system itself.

Any large school system is constantly needing sheet metal work of various kinds either for repairs or for new construction.

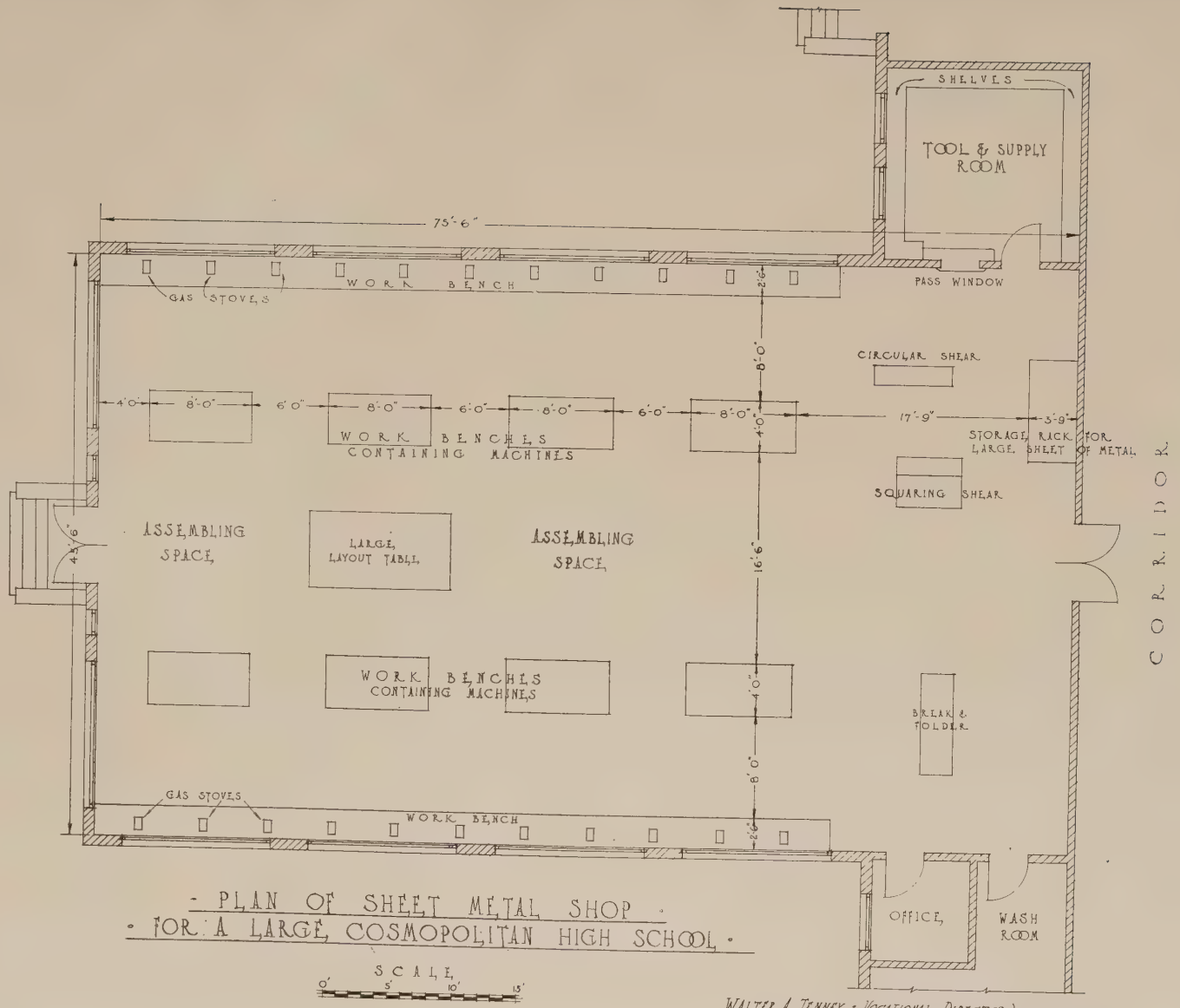
Work of this kind which has a real practical value is more interesting to students and has a far greater instructional value than mere practice or exercise work. Therefore the equipment of this, as of all the other high school shops, should be such as is found in commercial shops.

The Cabinet Shop (Figure 394). — The bench equipment would be the same as that described for the pattern shop. The tools furnished with each bench would be the same, except there would be no lathe tools. Several wooden saw horses, also a supply of wooden hand clamps, iron "C" clamps, and long bar clamps of different sizes should be provided. Also a supply of extra tools to be kept in the tool room, such as steel squares, extra bitts and ratchet braces, extra chisels, and gouges, hand saws both cross cut and rip, miter box and saw, special planes, gauges, scrapers, wood files, file cards, draw knives, carving tools, pliers, large dividers, inside and outside calipers of different sizes, several sets of lathe tools, etc., etc.

The machinery equipment for this shop should consist of:

Machine	Floor Space	Horse Power
1 16″ or 18″ Universal circular saw	4′ 5″ × 5′ 6″	5
1 16″ Swing cut-off saw with table	4′ 3″ × 18′ 0″ to 24′ 0″	3
1 36″ Band saw	3′ 6″ × 6′ 2″	5
1 30″ Cabinet planer	6′ 3″ × 7′ 3″	15
1 16″ Hand planer or jointer	2′ 8″ × 7′ 0″	5
1 Tenoner	4′ 8″ × 8′ 0″	5
1 Hollow chisel mortiser	3′ 0″ × 6′ 6″	3
1 Belt sander	6′ 0″ × 15′ 0″ to 24′ 0″	5
1 4″ × 36″ Grindstone	2′ 0″ × 3′ 6″	$\frac{1}{2}$
1 16″ × 10′ 0″ Lathe	1′ 10″ × 10′ 6″	3
1 12″ × 5′ 0″ Lathe	2′ 0″ × 5′ 2″	1
1 Universal wood trimmer	2′ 2″ × 4′ 0″	Hand

The saws, planers, tenoner, and sander should have a shaving exhaust system similar to those described in the equipment for the pattern shop. There should also be safety guards for all machines.



PLAN OF SHEET METAL SHOP
FOR A LARGE COSMOPOLITAN HIGH SCHOOL

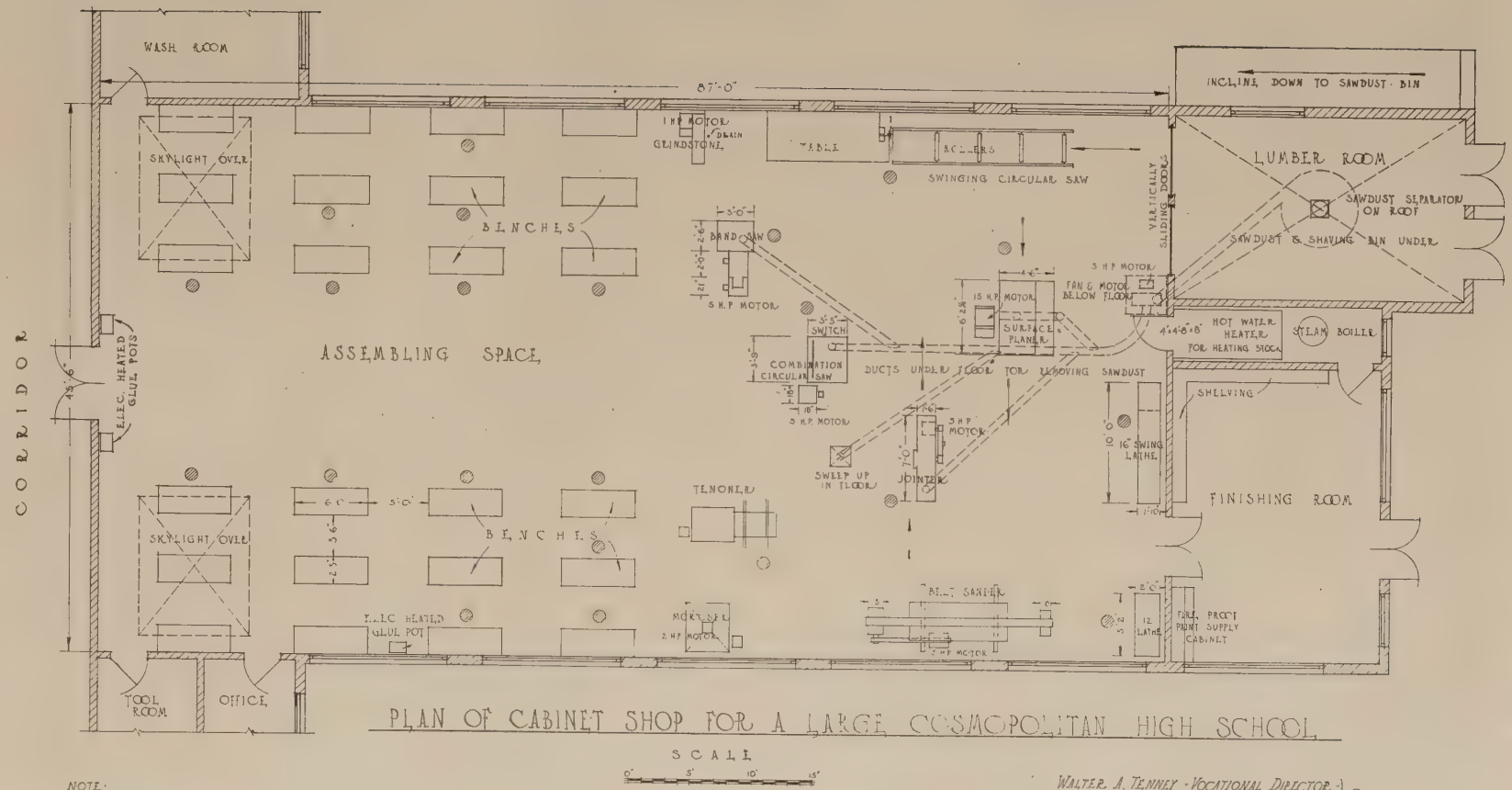
SCALE
0' 5' 10' 15'

WALTER A. TENNEY · VOCATIONAL DIRECTOR · } COLLABORATORS.
JOHN J. DONOVAN · ARCHITECT ·
OAKLAND · CALIFORNIA · MARCH · 26 · 1913 ·

FIG. 392.

Mr. Floyd A. Naramore, Architect

FIG. 393. — SHEET METAL SHOP, BENSON POLYTECHNIC HIGH SCHOOL, PORTLAND, OREGON.



PLAN OF CABINET SHOP FOR A LARGE COSMOPOLITAN HIGH SCHOOL

SCALE

NOTE. ◍ INDICATES POSITION OF THE STUDENT

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JOHN J. DONOVAN · ARCHITECT · } COLLABORATORS
OAKLAND · CALIFORNIA · FEBRUARY 20 · 1910 ·

FIG. 394.

Mr. John J. Donovan, Architect.

FIG. 395. — CABINET SHOP, OAKLAND TECHNICAL HIGH SCHOOL, OAKLAND, CALIFORNIA.

Mr. John J. Donovan, Architect.

FIG. 396. — MANUAL TRAINING ROOM, CLAWSON ELEMENTARY SCHOOL, OAKLAND, CALIFORNIA.

A steam-jacketed glue pot, heated by gas or electricity, should be provided, also a warming box for heating stock to be glued. The latter should be about $4' \times 4' \times 8'$ inside and may be built by students. It consists of a framework of $3'' \times 4''$ material mortised and tenoned together, boarded with $1'' \times 4''$ tongue and groove lumber, lined with asbestos and then with galvanized iron. The bottom is covered with one-inch steam pipes which are connected to a gas-operated steam generator. (See Figure 397.) If the building is steam heated, the warming box should also be connected to the main steam boiler, so as to utilize the steam from the heating system when it is in operation.

Adjoining the cabinet shop should be a finishing room about 20×24 feet, which can be heated to the proper temperature and closed against dust, when staining, varnishing and polishing furniture. A small office for the instructor about 8×10 feet is needed, also a tool and supply room about 10×15 feet, where extra tools and small supplies like screws, nails, glue, sandpaper, etc., are kept. In the tool room should be shelving and one or more cabinets similar to Figure 398.

A lumber room about 20×24 feet is needed. If possible it should be so located that lumber wagons can drive directly up to it. It should have racks built across it and doors all across the two ends (see Figure 394), so that lumber can be delivered directly off the wagon into one end of the lumber room and taken straight out of the other end into the shop, thus avoiding rehandling. Where there are several woodworking shops in the same school, one lumber room can sometimes be placed so as to serve two or more of them.

Figure 394 shows the arrangement of equipment on the floor, the benches near the windows to get the best light, leaving a large space in the center of the room for assembling work. Working space between benches should be not less than $3'$ $6''$ from side to side and $4'$ $6''$ from end to end. The machines are arranged at one end of the room with ample working space around them. The space between machines should seldom be less than 5 feet, and the planer, jointer and circular saw should be so placed that long lumber can be machined on them without interference. School shops are sometimes so

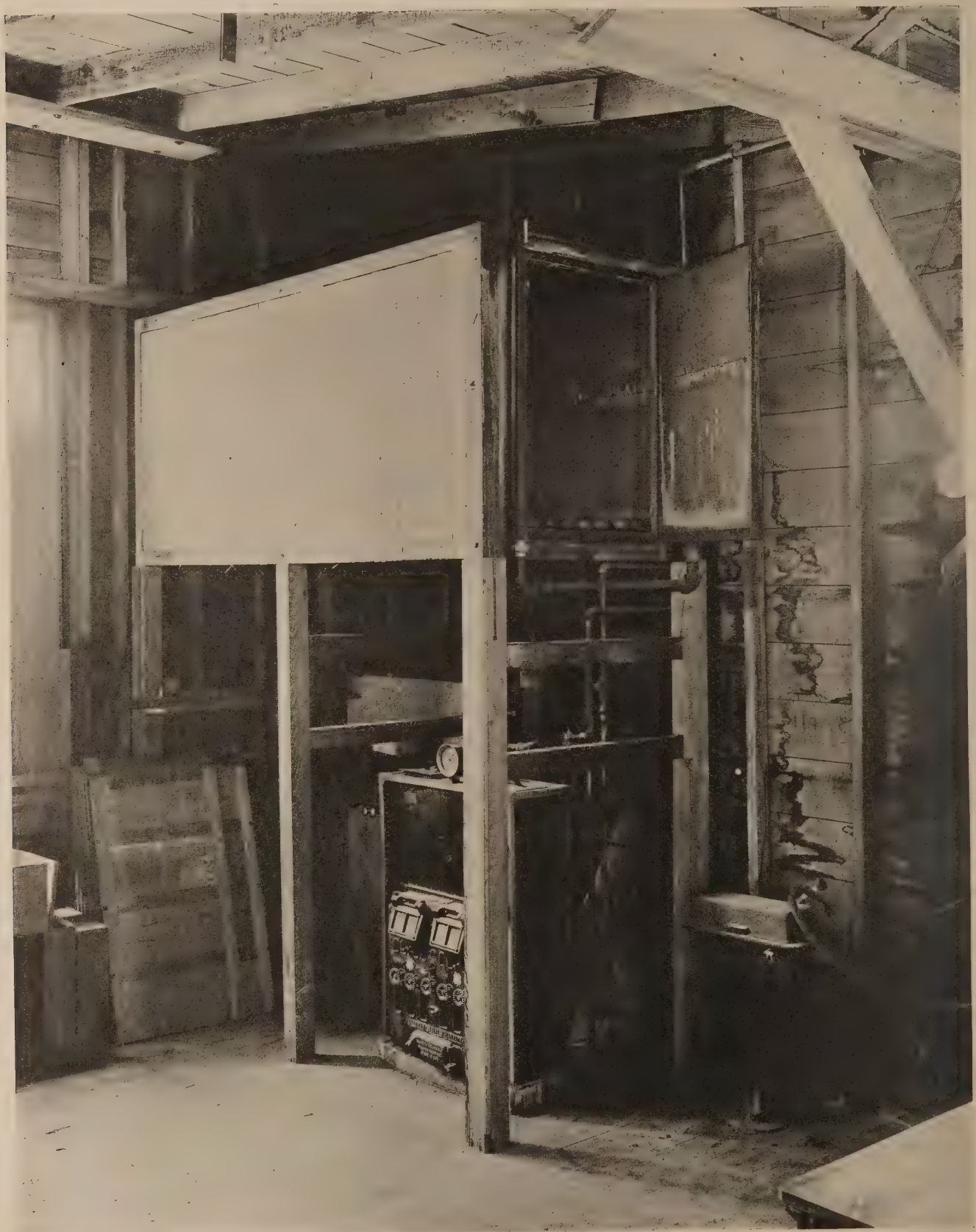


FIG. 397. — WARMING BOX AND STEAM GENERATOR.

planned that the woodworking machines are placed in a separate room called the mill room. The writer does not approve of this plan, because dangerous machinery should always be under the eye of the instructor, and if in a separate room, this will be impossible.

The Carpentry Shop (Figure 399). — Unless the cabinet shop is a much larger room than that shown in Figure 394, the carpentry shop should be a separate room. The equipment would be much more simple and inexpensive than that described for the other woodworking shops. No machinery would be needed, as the joinery and interior finish would come under the head of mill cabinet work, and would be gotten out in the cabinet shop. There should be several carpenters' benches against the walls, leaving nearly the whole floor space for the erecting of models in carpentry, sections, and complete frames of buildings at a reduced scale, also full size sections of buildings, roof and other framing, stair work, and so forth, requiring a large floor space.

Instead of tool drawers in the benches, each student should have a locked tool box (such as a carpenter carries on to the building with him) and the usual kit of carpenters' tools. These would be:

Steel square.
Cross cut saw.
Rip saw.
Hammer.
Level.
Plumb bob and line.
Hatchet.
Try square.
Bevel.
Drawknife.
Jack plane.
Smooth plane.
Block plane.
Bit brace.
Set of bits.

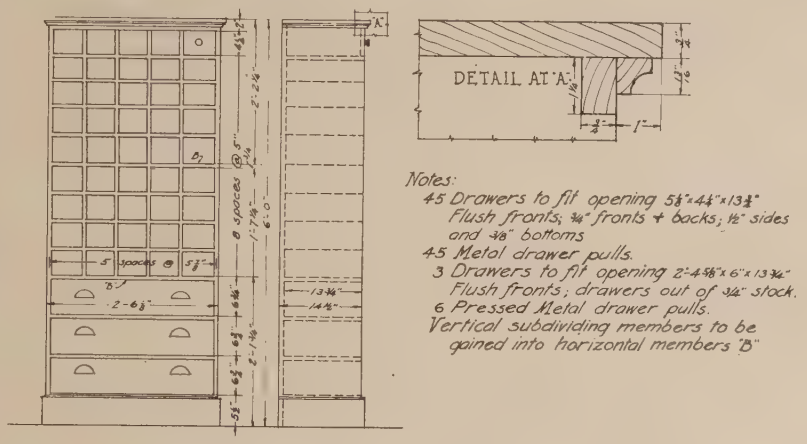
Extra and special tools would be kept in the tool room. A number of sawhorses should be furnished. The carpenter's bench would be larger and of a different construction from that in the other woodworking shops.

An office and tool room will be needed as in the other shops, and against one wall should be a set of lockers in which the students could lock up their tool boxes when not using them.

Since this shop joins the cabinet shop, the lumber for both might be kept in the cabinet shop lumber room and brought into the carpentry shop on trucks provided for that purpose. A small quantity might also be stacked in racks against the wall, as indicated on the plan.

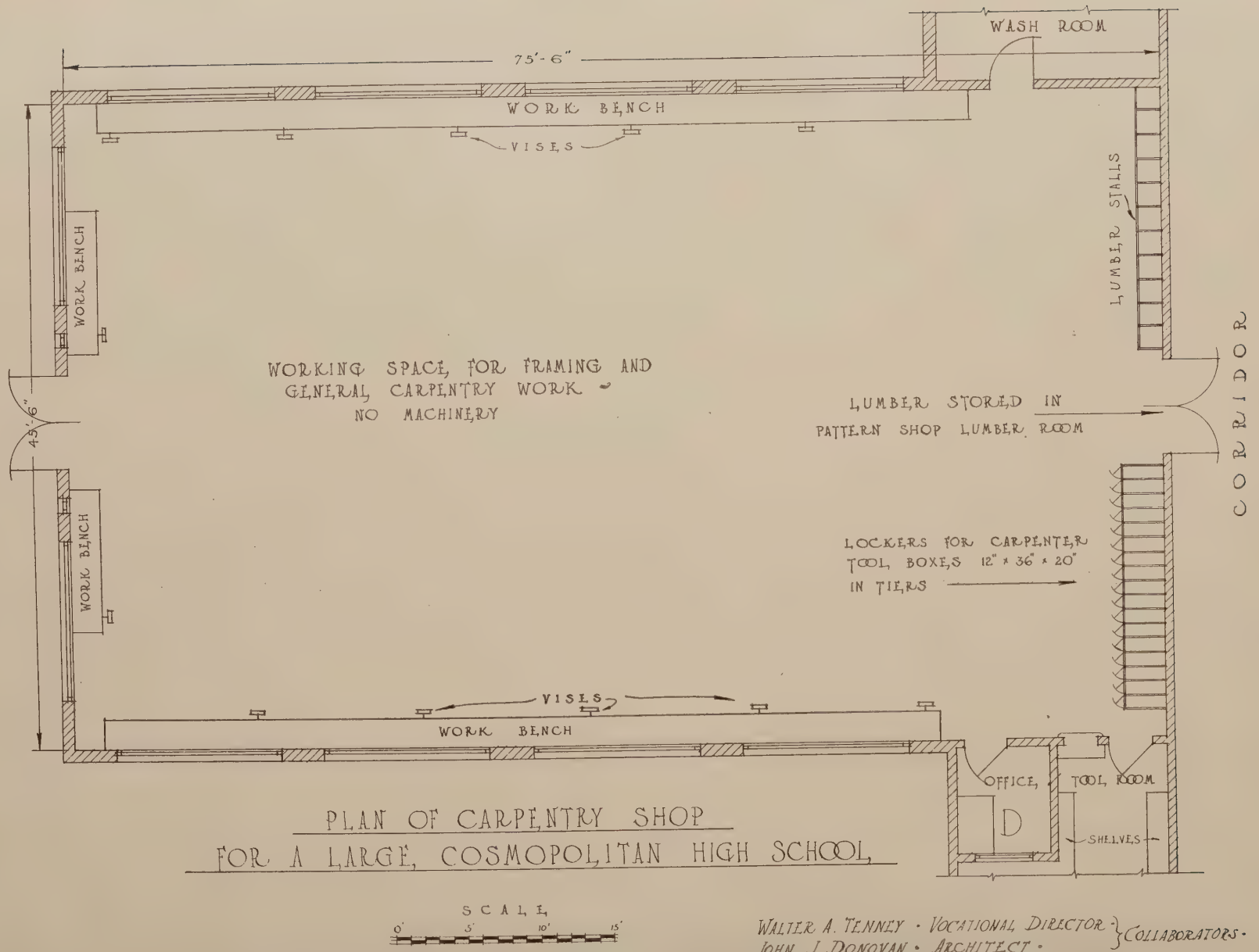
The Exhibit Room (Figure 400). — Just as a photograph or drawing will convey certain kinds of information at a glance more satisfactorily than can be gathered from pages of printed matter, so an exhibit of work done in the industrial departments of a high school will convey, to the mind of the interested parent or student, valuable information as to the scope and character of the courses, more quickly and satisfactorily than any other means. If, therefore, conditions will admit of it, an exhibit room should be provided as an important feature of the school plant. It should be prominently located, if possible, on the street side of the building (with an entrance from the street), so as to be a standing advertisement to passers-by, constantly drawing the attention of the public to the work of the school. The room should be of generous size, especially if the school be large and contain many industrial departments, so that each department may have its own space, large enough to admit of a fairly comprehensive exhibit. There should be ample light, both natural and artificial. The artificial lighting will need to be planned with special reference to each part of the exhibit, and the manner in which the exhibit is arranged, so as to show it to the best advantage.

The method of arranging the exhibits will vary with the character of the material displayed. Some, as, for example, pieces of furniture or machines, will require floor space only, others will require tables or shelves. Again, work like millinery or dressmaking should be


DETAIL AT 'A'
Notes:
45 Drawers to fit opening 5⅛"×44"×13¾"
Flush fronts; ¾" fronts + backs; ½" sides and ⅜" bottoms
45 Metal drawer pulls.
3 Drawers to fit opening 2'-4⅝"×6"×13¾"
Flush fronts; drawers out of ¾" stock.
6 Pressed Metal drawer pulls.
Vertical subdividing members to be gained into horizontal members 'B'

·TOOL ROOM SUPPLY CABINET·
SCALE

FIG. 398.



PLAN OF CARPENTRY SHOP
FOR A LARGE, COSMOPOLITAN HIGH SCHOOL,

WALTER A. TENNEY · VOCATIONAL DIRECTOR } COLLABORATORS ·
JOHN J. DONOVAN · ARCHITECT ·
OAKLAND · CALIFORNIA · FEBRUARY · 25 · 1919 ·

FIG. 399.

shown in glass cases, while drawings and some other articles should be arranged upon walls or upon displayers, having large vertical leaves.

The Central Storeroom (Figure 400). — In a large plant, like the one here discussed, large quantities of supplies are annually purchased and distributed to various departments. In any well-managed institution, transactions of such magnitude must be systematically checked and recorded. In the school plant this can be best accomplished by having a central storeroom, where all supplies, of every kind, whether for academic or industrial departments, are delivered. This room should be located so that teams can drive up to it and deliver all supplies directly from the wagon, and doors of ample size should be provided for admitting readily large crates or packages.

An exception should be made of wood, coal, or fuel oil for heating the school plant, and of blacksmith coal for the forge shop. Wood and coal should be delivered and stored near where they will be used. Fuel oil should be stored in tanks under the sidewalk and piped to the furnaces.

Lumber for the carpentry, cabinet, or pattern shops might be kept in special storerooms adjoining the shops in which it is to be used. But if the central storeroom can be made large enough, and located within easy access of the wood shops, it is better to have the lumber stored there and delivered to the shops as needed. The supply room adjoining each shop could then be very small, holding only a supply for immediate use, or it could be omitted altogether.

Supplies should be requisitioned by the different departments as needed. They should be issued by the storeroom clerk, and charged to the department receiving them.

This room should be provided with shelves of various widths, wide shelves for holding paper stock for the print shop, and narrower ones for such other supplies as are best kept on shelves. There should be bins for other types of supplies such as plumbing fittings, etc., racks for steel and iron, both sheets, bars and pipe, and drawers for small supplies such as nuts, machine screws, cabinet-makers' hardware, etc. The room should be fireproof, and metal tanks provided for storing oils and gasoline.

A power hack saw should be placed in this room, also a platform scale, so that orders for steel or iron from the shops can be cut to size, and the quantity recorded exactly.

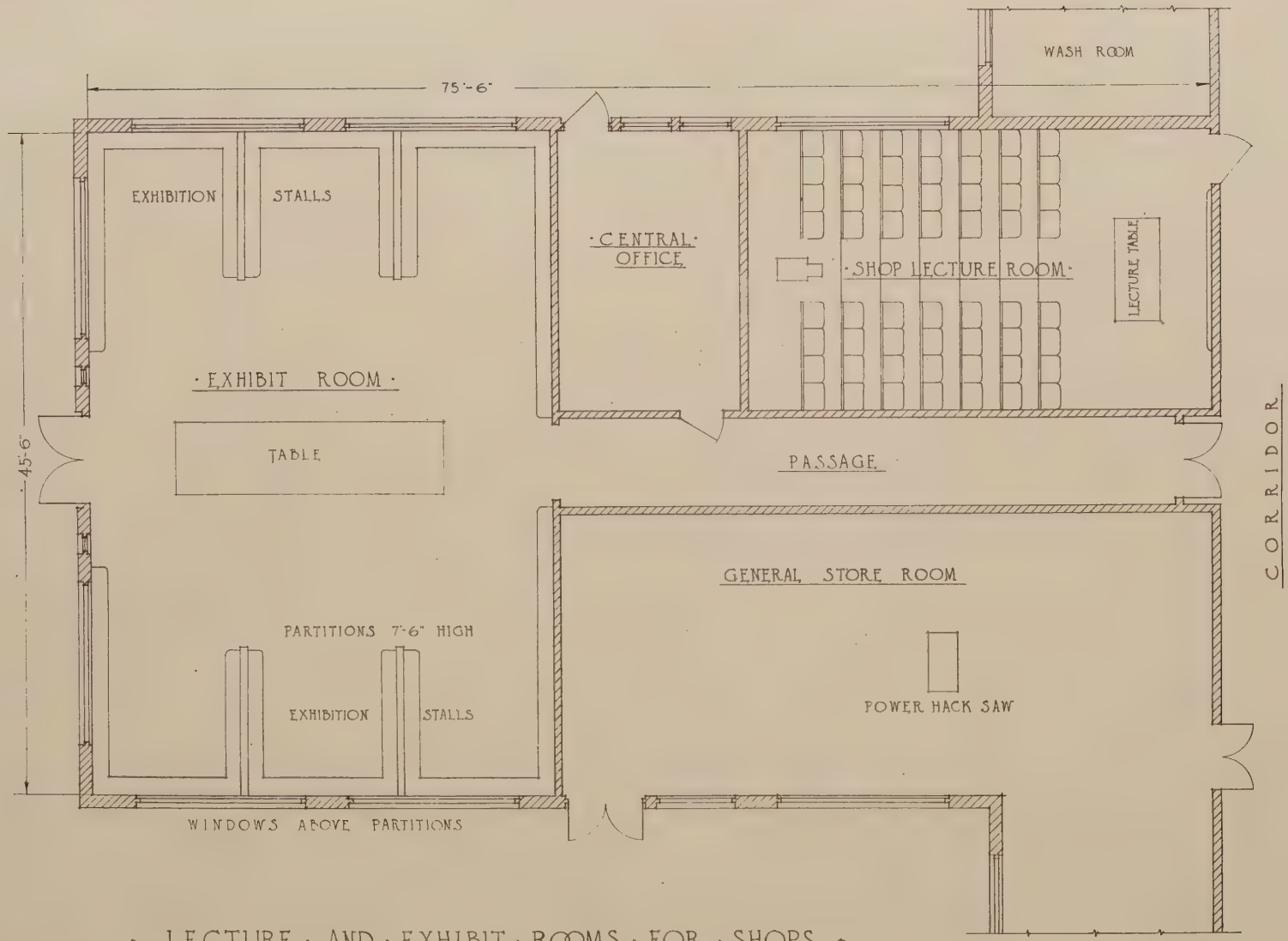
In addition to the book accounts, as a means of facilitating stock taking, a manila tag should be attached to each bin, drawer, rack, or shelf, one for each kind of material kept in stock. On the tag should be entered the quantity of materials on hand. As material is drawn from this supply the quantity drawn each time should be entered on the tag and the balance brought down; thus the tag shows at all times the quantity of stock on hand. The writer has operated such a storeroom in connection with his school and found it very satisfactory.

If the shops are built as a separate structure, as shown in these plans, then a main office for the shop building, centrally located, should be provided for the head of the industrial arts department. This office should be connected by telephone with all the shops, and also with the principal's office and the outside. The central office in this plan is shown adjoining the lecture and exhibit rooms.

The Intermediate or Junior High School Shops. — One of the most important developments in recent educational policy is the intermediate school. Comprising the seventh, eighth, and ninth grades, it forms the connecting link between the elementary and high schools, and should partake of the character of both.

In the elementary school the pupil lays his educational foundation in a study of the fundamentals. In the high school he begins to specialize, and his election of courses should be determined largely by life career motives. The intermediate school should provide means for a gradual transition from elementary to high school methods. It should offer an opportunity for the student to try many different kinds of work, both academic and industrial or vocational, to discover his likes and dislikes, his aptitudes and limitations, that he may more intelligently choose his high school course. Vocational guidance should be commenced in the intermediate school. And if the student does not continue through the high school, there is even greater need for the widest opportunity for self-analysis and discovery, for investigation and experimentation, as an aid to choosing a vocation or life career. Therefore, on the industrial side, the intermediate school should provide equipment that will enable the student to gain some knowledge of the general characteristics and fundamental processes of a number of occupations, at least sufficient to help him decide whether he would like any particular occupation, or is adapted to it.

Since the students will not specialize, but will investigate many lines of work in this school, the equipment will be neither as expensive nor as complete as in the high school. It is much better to have simple equipments for many different kinds of work than to have one or two shops expensively equipped. The general principles of shop planning laid down for high schools, and the data on equipment, floor space, power, etc., already given, are easily adaptable to the planning of shops for the intermediate school. In a small



LECTURE · AND · EXHIBIT · ROOMS · FOR · SHOPS

SCALE
0' 5' 10' 15'

WALTER A TENNEY · VOCATIONAL DIRECTOR
JOHN J. DONOVAN · ARCHITECT
} COLLABORATORS
OAKLAND · CALIFORNIA · JUNE · 12 · 1919

FIG. 400.

intermediate school where but one shop for boys' work is provided, it should be a general utility shop. One large shop could be so equipped that introductory work in carpentry, cabinetmaking, pattern making, electrical work, sheet metal work, plumbing, machine shop work, and forging can be given. Twenty-five to thirty work benches similar to those described for the pattern or cabinet shops should be furnished. By making a slight change in the benches so that a woodworking vise may be placed on one side and a machinist vise on the other, these could be used for all purposes for which a bench is needed. Or, if preferred, part of the benches could be equipped with woodworking vises and the rest with machinist vises.

In addition to benches and hand tools, four to six wood-turning lathes, a circular saw, band saw, planer, and a grindstone will give sufficient woodworking equipment for doing the three lines of wood work mentioned above. By selecting a very moderate amount of equipment from the list given under "Sheet Metal Shop," including a few gas soldering stoves, soldering coppers, snips, tinners, rolls, turning, wiring, setting down, and burring machines, several stakes, etc., a beginning course in sheet metal work can be given. The same suggestion applies to electrical work and plumbing.

One or more forges of the hand blower type, two or three screw-cutting engine lathes about nine-inch to fourteen-inch swing, a small shaper, a drill press, an emery grinder, and small hand milling machine with the necessary hand tools will provide for an introductory course in forging and machine shop work.

In the larger intermediate school, more shops should be provided, and additional equipment for each of them. For example, all the woodworking equipment in one shop, the sheet metal and plumbing in one, and forging and machine shop work in another. In a very large intermediate school this idea might be extended to the point of providing a separate shop and more extensive equipment for each kind of work; however, the equipment should be more simple and less expensive than in the high school shops.

A printing shop is very desirable in the intermediate school, largely for its educational value, it being a great aid to teaching English. Two or three platen presses, sizes eight by twelve to ten by fifteen inches, preferably motor-driven, two or three imposing stones, eight or ten type cases with a good assortment of type, a paper cutter hand-operated, a stapling machine, proof press, and other small accessories should be provided.

In a word, the industrial department in an intermediate school should be planned and equipped for introductory work only, not to give a vocational course, but to enable the student to decide whether he wants to go on to the high school and take a vocational course, or whether he is better adapted to some line of work outside the industrial field, or if compelled to leave school during his intermediate course to earn his living, to enable him to choose intelligently the occupation he will enter.

Conclusion. — This chapter has been written with a view of giving accurate, usable data regarding the equipment needed for the various kinds of shop work most commonly taught in manual training and technical schools, its general arrangement in the shops for efficient operation, the floor space required for each machine and the horse power required to run it. So far as known, this detailed information has never before been brought together in compact form, and could only be obtained by consulting a large number of catalogues and reference books, or by extensive correspondence with dealers. Definite information on these matters is the first requirement on the part of the technical school director or instructor who is planning to introduce industrial or vocational courses, or of the architect who is designing rooms or buildings for these courses.

The information here given has been gathered by the writer during years of experience in planning, equipping, and managing industrial schools, and he believes it will be found reliable. From the data given in this chapter, school men or architects should be able to make selections and arrangements that will meet the requirements for shops or manual training rooms in schools of all sizes and under all conditions, from the small intermediate school having one general utility shop to the large cosmopolitan high school offering trade and technical instruction in many different vocations.

CHAPTER XXIII

THE HOME ECONOMICS DEPARTMENT

By Agnes Fay Morgan, Ph.D., *Associate Professor of Household Science, University of California*

Part I: Statement of the Problem. The Development of Home Economics Education. The New Meaning of Home Economics Education. Trade Education Growing out of the Domestic Arts. General Education Through Domestic Applications. Necessary Change in the Teaching of Home Economics.

Part II: Equipment of the Elementary and Secondary Schools for Instruction in Home Economics. Location and Number of Rooms. The Cooking Unit. The Serving Unit. The Laundry Unit. The Housekeeping and Home Nursing Unit. The Clothing Unit.

PART I

Statement of the Problem. — The problem of planning and equipping laboratories for household science classes in the lower schools is complicated by the changing character of the material presented under this name. It may be too soon to venture any suggestions as to standard rooms for this work, certainly too soon to assume that the last word can be said in the matter. Since the mobility of the subject inheres not only in the actual material presented but in the ideals set up from time to time as representing the goals to be attained by such instruction, the character of equipment used must likewise remain somewhat uncertain.

The Development of Home Economics Education. — If one follows briefly the history of the home economics education movement it is possible to see the reason for this state of change. In the beginning, perhaps as early as 1870, there were developing two separate movements for women's education in matters pertaining to the home. The one in the East, begun by the Woman's Education Association in Boston, consisted of a series of excellent cooking schools, of which the Boston Cooking School is the best known. Under such leaders as Miss Parloa, Mrs. Rorer, Mrs. Lincoln, Miss Farmer, these schools undertook to train as skilled cooks any pupils, both adults and children, who came to them. These schools lasted about twenty-five years, and accomplished much in the way of introduction to the establishment of cooking as a part of the public school instruction for girls.

The movement in the West, inaugurated by the agricultural colleges at about the same time as that in the East, was the result of the provisions of the Morrill Act.[1] Since the land-grant colleges, created by this act, were open to women students, some provision had to be made for their peculiar interests, and as a result the Colleges of Agriculture of Iowa, Illinois, Kansas, and other middle western states began about the same time to offer courses in household science, domestic science, or domestic economy, as the subject was variously called. The students enrolled in the classes were in general better prepared for possible mental as well as manual development of the subject than those in the eastern cooking schools. The presence of a staff of chemists, physicists, physiologists, and other scientists in the agricultural colleges made natural the attempt to correlate the cooking or food work, as it was now called, with the already established courses in the science departments. That this correlation was and still is imperfectly established detracts not at all from the fundamental importance and value of this step.[2]

The question of the educational as well as utilitarian value of instruction in the manipulation of foods, of clothing construction, and housing problems has been much discussed among educators, and such instruction has been admitted to the schools upon the same basis as the training in the manual trades for boys. There has been claimed, however, a peculiar universality for the domestic problem in the lives of women, as distinguished from the specialization in trades and professions by men. It is in acknowledgment of this claim that training for the home has been so readily and generally introduced into the public grade and high school curricula. But the status of women as wage earners, as well as the machinery of the home itself,

[1] In 1862 Congress passed a bill, often called the Morrill Act, granting 30,000 acres of land to each state for each senator and representative, for the maintenance of agricultural schools. The state colleges of agriculture have developed out of these land-grant schools.

[2] For further history of this development see *The Home Economics Movement*, by I. Bevier and S. Usher, Whitcomb and Barrows, 1906.

has been rapidly changing in the last decade. Education for trades and professions must now be provided for girls as well as for boys, and the real usefulness of the technique and the culture conveyed under the name of home economics must be constantly proved anew.

The New Meaning of Home Economics Education. — Out of the critical consideration of the changing American home has come gradually, and as yet vaguely, a new twofold interpretation of domestic education. On the one hand has developed the vocational, practical training in the doing of the daily manual tasks about the home, an interpretation favored by the Federal Board for Vocational Education and of particular applicability to girls of the junior high school age, and to those enrolled in continuation and special classes. This type of education has been called by Snedden [1] "home-making" as contrasted with "household arts," a cultural course. Such a term can hardly be accepted as final, for the word *home* connotes all the intangible social and spiritual relations of the family, preparation for which is dependent upon fundamental education, as well as the physical surroundings and service of the house. The type of domestic education demanded by the Smith-Hughes Act as interpreted by the Federal Board for Vocational Education [2] largely excludes the study of anything but the latter.

Trade Education Growing Out of the Domestic Arts. — Out of this training there is emerging a definite body of trade or industrial preparation, since the industries which have left the home may still be followed most easily by girls trained in the so-called domestic arts. We have thus the anomaly of home economics education leading to wage earning outside the home. Such trades are, of course, chiefly concerned with garment and hat making or selling; the cooking and serving of food; the decoration, cleaning, and managing of the house; laundering; and care of children and the sick. Courses leading to skill in any of these occupations may well be termed vocational. Whether a general smattering of all of them may very long be considered vocational is questionable, for even where paid employees take over the labor in the modern home the trend of such service is still toward specialization in a few of the duties involved. The view that any large number of young girls may choose an education which shall fit them only for performing the physical tasks and for making the material choices involved in the conducting of their own future households, is surely no longer tenable. The conclusion from these assumptions would seem to be that the technical training for household tasks should discard much of its present amateur character and take on an intensive professional attitude with definite outlook toward permanent and paid occupations.

General Education through Domestic Applications. — The second interpretation now read into home economics is that of education in economics, science, and art conveyed to young students through applications inevitably met in the American home. It is increasingly apparent that such education properly modified should be available to boys as well as to girls.

The new conception of the order in which information, perception, and reasoning may be used in education makes it possible to consider the teaching of chemistry at least partly through food classifications, cleaning, painting, dyeing; physics through cooking, machines, ventilation, lighting, heating; design through carpets, costumes, wall-paper; accounting through the household budget. Of course, home economics subjects furnish only one of many avenues of instruction of this type, hygiene, physical education, dramatics, shop and trade training, and agriculture being some of the others.

Whether the household applications be considered a vehicle for the teaching of the formal sciences and arts, or these formal subjects the subordinated means of explanation of everyday phenomena, the fact remains that modern education finds it possible and profitable to combine these two formerly unrelated fields. As one result, the appliances and technique formerly grudgingly allowed a small share of school time as a concession to future practical household needs, may now be welcomed as furnishing avenues of interest for academic instruction.

If these avenues are to lead to valuable training for citizenship and more abundant life, the teachers of household subjects must present broader and deeper preparation in those subjects fundamental to the applications taught than was formerly the rule. Technique in cooking, laundering, and sewing must surely become subordinate to explanation in terms which shall connect each operation with the general law which it is used to illustrate. The "why" instead of the "how" of the phenomena of everyday life would thus become the main objective of the teacher of home economics.

Necessary Change in the Teaching of Home Economics. — This latter conception of the function of education for the home would seem to be emerging as the permanent phase into which the movement can be expected to develop. It is founded upon no assumption as to the status of the home, nor as to the duties of women in society, and may therefore be safely embedded in a sternly critical and utilitarian scheme of general education. That the teaching of the subject must be radically

[1] Snedden — *Problems of Secondary Education*, 1917, Chapter 23.
[2] Federal Board for Vocational Education, Bulletin No. 28, pages 23 to 25, 1918.

altered in order to fit into such a scheme is readily admitted, and even more apparent, therefore, is the need for a sweeping change in the training of teachers for the primary and secondary grades. Such a change would need to be constantly directed toward the elimination of the amateurish and sentimental attitude of mind of these teachers, away from the limitations of home and housewife's conditions for every operation, and toward professional, commercial, and scientific, or co-operative enterprises.

If home economics education is to be either vocational in the specialized sense, or cultural in the sense that it may be used as a pedagogical device for the imparting of general basic information as well as for illustration of the scientific method, two distinct criteria must be applied to the type of equipment chosen for the schools in which such instruction is to be given. Practical equipment of the same size and kind in use in the community should be installed for the former purpose, and a variety of scientific and simplified equipment for the latter. The elementary schools should, in general, be provided generously with practical appliances, the intermediate and secondary schools should have both types, since only in the higher grades can the more complicated phenomena of life be explained at all by concrete domestic problems.

PART II

Equipment of the Elementary and Secondary Schools for Instruction in Home Economics. — It is now the general practice to provide space for the teaching of home economics subjects in connecting rooms arranged more or less in the order of an apartment or house. Five units may be distinguished in this space: (1) the cooking unit; (2) the serving unit; (3) the laundry unit; (4) the sewing unit; (5) the home nursing and housekeeping unit. Of these only the cooking and sewing units are usually considered indispensable, and are first supplied, the serving, laundry, and housekeeping units being most frequently added in the order named. When the space provided is small, a single room may be utilized for instruction in all the varieties of home economics subjects by means of suitable portable equipment, or two rooms may be made to answer all purposes adequately.

Location and Number of Rooms. — Formerly the domestic science rooms were often devised at the last minute in both new and old school buildings out of left-over basement space. Poor lighting, ventilation, and heating were usually the result, and cooking odors pervading the whole building added to the general dissatisfaction. This unfortunate placing is less often encountered of late years.

The home economics rooms might well occupy a separate building or a separate wing from the rest of the school. If this is impossible the cooking-room should be placed either on the first or second floor, or near the lunchroom, for convenience in delivery of supplies. If all home economics instruction can be assembled in a separate building, either in the form of a cottage or apartment, a certain unity and concentration is gained, the value of which can hardly be overestimated. Lessons learned in physical surroundings not unlike those of the homes of the children are more apt to be carried over into immediate home life than if the usual school environment is used. At the same time care must be taken that home economics lessons shall not be so dissociated from the ordinary school atmosphere as to attain a separated and sometimes an inferior rating in the pupil's mind. This danger can, however, be obviated only by the diligent care and improved training of the home economics teacher.

The same advantage presented by the detached building may be obtained by the use of a separate wing for these rooms. Such a wing may be planned for either one or two floors; the cooking, serving, and laundry units on one floor, if necessary; and the sewing and housekeeping units on the other. If the apartment plan be used it is usually found convenient and economical to provide the following rooms, as illustrated in Figures 401 and 402: (1) A room of generous size, at least 480 square feet, which may be used as a living-room for the teaching of housekeeping and interior decoration, and as a community or school social room when occasion demands. (2) A smaller room providing at least 200 square feet of floor space communicating with the former and also with the kitchen, to be used as a dining-room and recitation room, or to be united with the living-room when larger space is required for lectures or social meetings. (3) A bedroom and bath-room to be used for instruction in housekeeping, home nursing, first aid, care of children, and at other times as a rest-room for teachers or pupils. (4) A room, varying in size with the needs of the classes to be held, for instruction in cooking. At least one ordinary sized family kitchen should be included in the latter space, and also laboratory desks or long tables for class instruction, as well as a pantry or storage cupboards. (5) A laundry, equipped with stationary and portable tubs, dryer, ironing boards, and benches. This room should be compact, and separated from the cooking room if possible. (6) A sewing-room equipped with tables, chairs, sewing machines, pressing boards, and walled-off or screened fitting place. The living-room mentioned above under (1), if necessary, may be used as sewing-room.

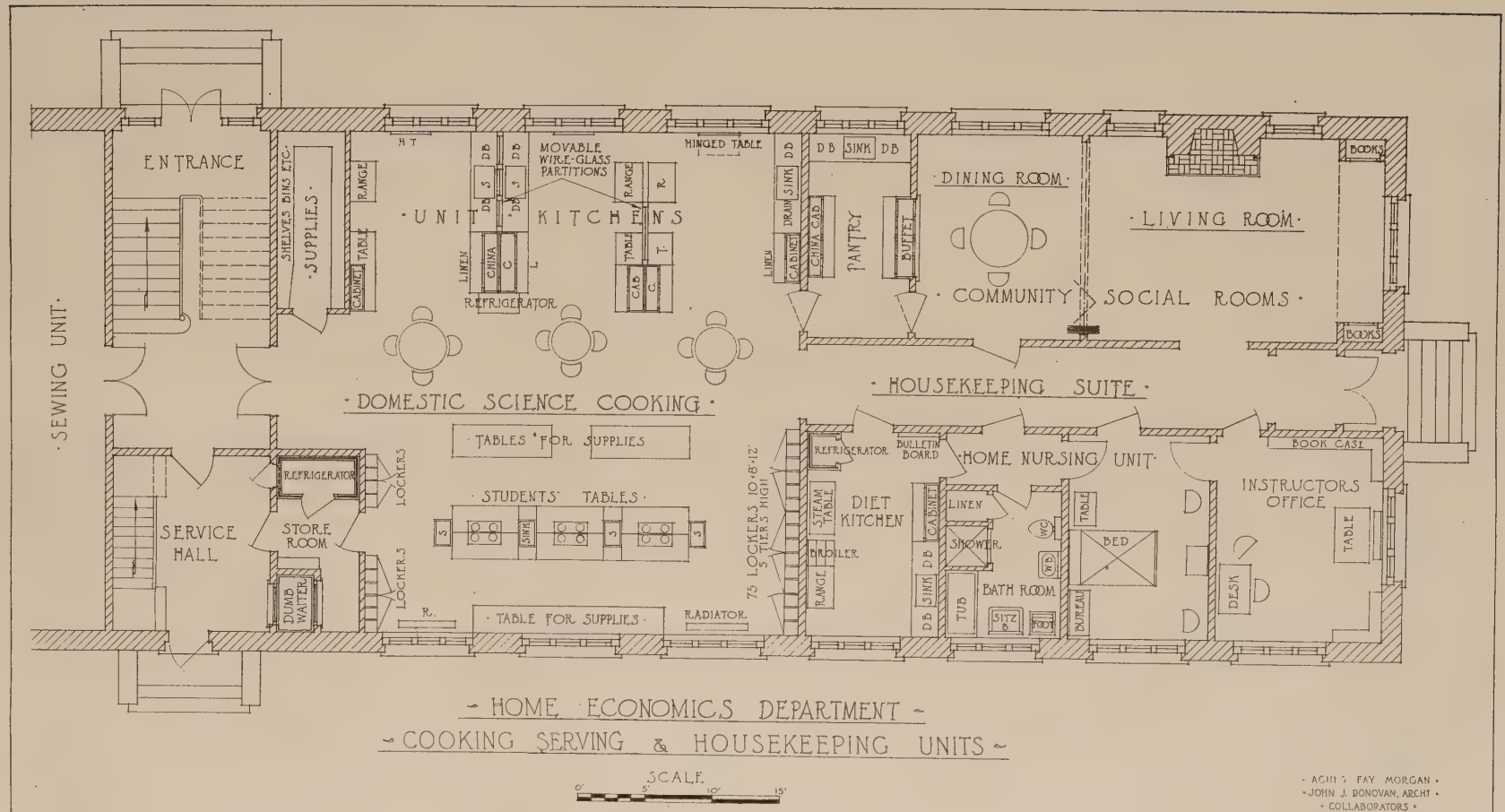

ENTRANCE
SHELVES BINS ETC.
SUPPLIES
RANGE
TABLE
CABINET
H T
MOVABLE WIRE-GLASS PARTITIONS
HINGED TABLE
UNIT KITCHENS
DB
SINK
DRAIN SINK
CHINA CAB.
LINEN CABINET
PANTRY
BUFFET
DINING ROOM
LIVING ROOM
BOOKS
COMMUNITY SOCIAL ROOMS
SEWING UNIT
REFRIGERATOR
DOMESTIC SCIENCE COOKING
TABLES FOR SUPPLIES
STUDENTS' TABLES
HOUSEKEEPING SUITE
BULLETIN BOARD
HOME NURSING UNIT
BOOK CASE
INSTRUCTORS OFFICE
LOCKERS
SERVICE HALL
STORE ROOM
DUMB WAITER
TABLE FOR SUPPLIES
RADIATOR
75 LOCKERS 10·8·12 5 TIERS HIGH
STEAM TABLE
BROILER
DIET KITCHEN
LINEN
SHOWER
BATH ROOM
TUB
SITZ
BED
DESK
BUREAU
HOME ECONOMICS DEPARTMENT
COOKING SERVING & HOUSEKEEPING UNITS
SCALE
0' 5' 10' 15'
AGNES FAY MORGAN
JOHN J. DONOVAN, ARCHT
COLLABORATORS

FIG. 401.

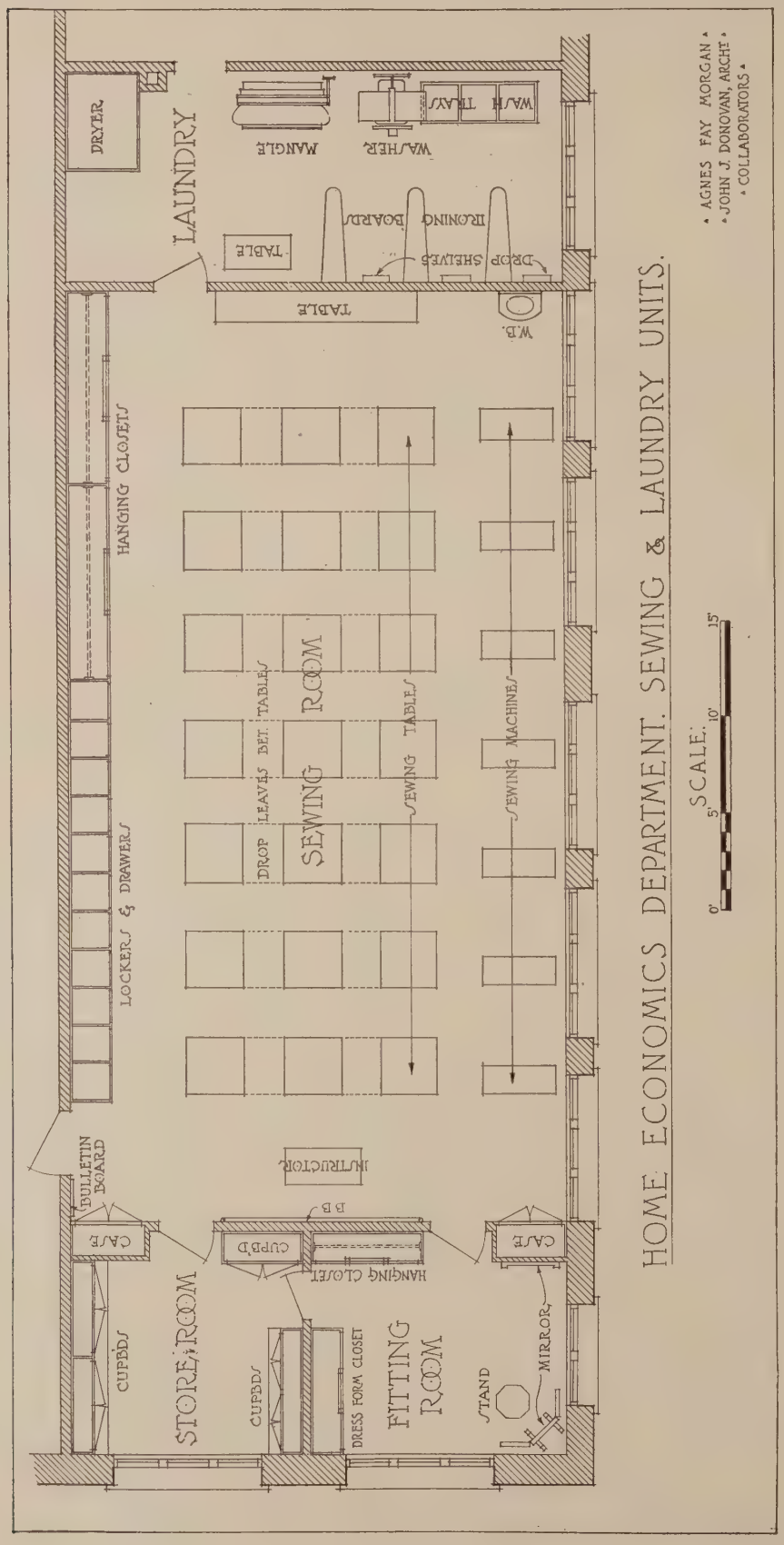


Fig. 402.

In the following discussion of the six rooms, comprising five units mentioned above, no reference as a rule will be made to the absolute cost of the equipment suggested, for it seems to the writer that any such discussion should assume ideal conditions, without other limitation than that of educational efficiency. The reader who may be interested in the practical materialization of these plans, and who will usually encounter the difficulties of limited expenditure, must make for himself the choice of apparatus and space which his purse, his community requirements, and his teaching staff demand. The quotation of definite prices on any of the articles suggested seems inadvisable because of the rapidly changing character of such prices and because of the lack of uniformity in this matter in various parts of the country.

The Cooking Unit.—1. *Types of Arrangement.*—Two types of laboratory arrangement have been developed for the teaching of cooking in the schools. The older and still more frequently met may be called the *laboratory desk type*, the newer has been called the *unit kitchen type*. In the former the usual science laboratory arrangement of long tables or rows of tables is used; in the latter small inclosures imitating in arrangement and equipment the home kitchens.

The laboratory desk type developed naturally from the classroom habit of teaching, and with certain modifications may still be considered the most efficient, practical, and lasting equipment for the teaching of young pupils. The objection to this type of equipment is, of course, the obvious one that it does not reproduce home conditions.

There is no serious belief by any one experienced in the administration of home economics education that home conditions can ever be effectually reproduced in the schools, or even that such a reproduction, if attained, would be altogether desirable. In the limited time that can be assigned to domestic training, the larger part of the teaching of the subject to normal girls, aged 11 to 18 years, should be concerned with the economic and scientific principles underlying the purchase and preparation of food, rather than with the manual technique, "the skills," involved in handling those foods. Expertness in manipulation admittedly cannot be attained in all types of food preparation, even in the most indefensibly extended school course in cooking. The emphasis, then, should be placed upon mastery of the tools, in the sense described above, with the expectation that skill in handling will be attained on the job.

Home economics education, even when viewed as vocational, must in this respect resemble medical or engineering education rather than trade training. Skill in the performance of manual operations plays surprisingly small part in the efficiency of even the rural and village American housewife to-day, while great value is attached to intelligent choice of material, expenditure of time and money, management of children and leisure time. An analysis of the housewife's day in the middle class American home would undoubtedly reveal constant choices, planning, weighing of values, and some manual labor largely of a primitive and easily mastered type.

The equipment for training future housewives should therefore provide for the demonstration of fundamental truths, rather than the uninspired reproduction of familiar and unanalyzed conditions. Since it appears that an analyzed and suggestive reproduction of such conditions should furnish the desired medium for instruction, a third type of arrangement, which is a combination of laboratory desk and unit kitchen, is here suggested. This *unit desk* arrangement as shown in Figure 403 may in convenient working space exhibit all the elements shown in the home kitchen, without the objectionable features of the laboratory fitted out with unit kitchens only. These objectionable features are, in order of increasing importance, the waste of space and therefore of pupils' time, difficulty of supervision by one teacher, and inadequacy of group work.

Some of these same objections may be raised in criticism of certain types of the laboratory arrangement, particularly the hollow square type, for so many years the standard in all parts of the United

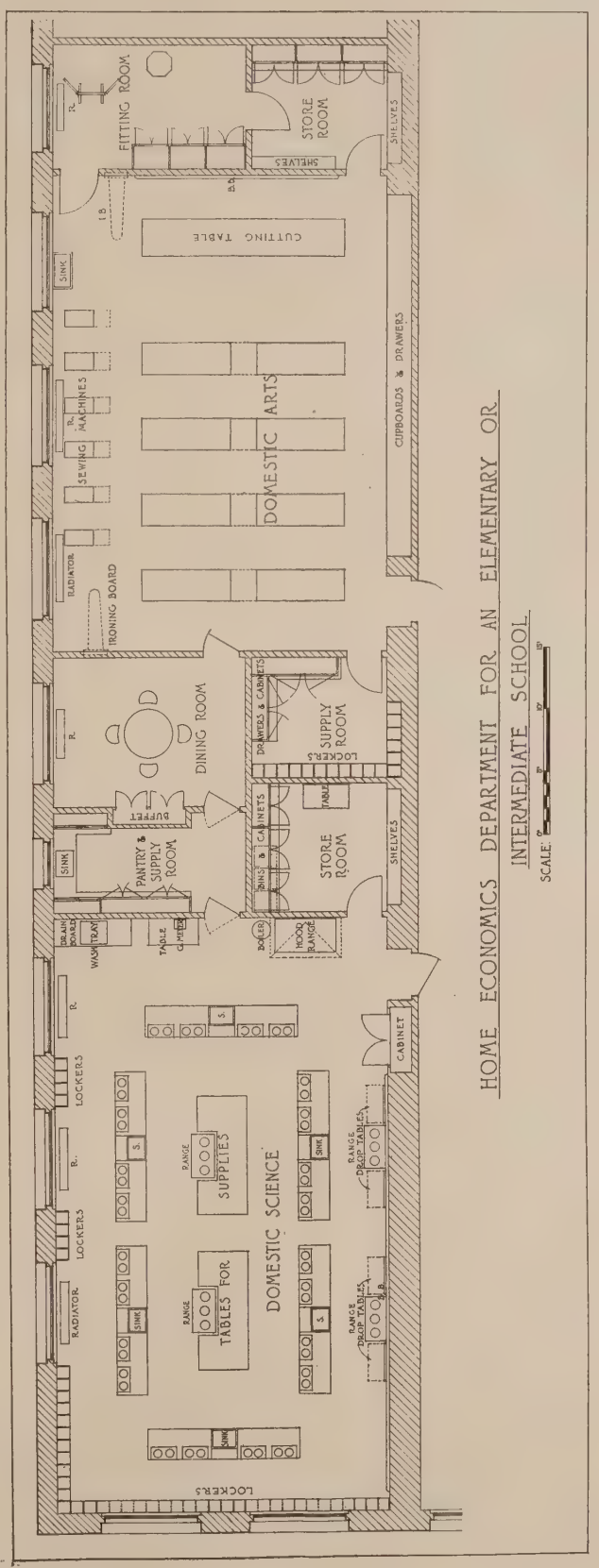
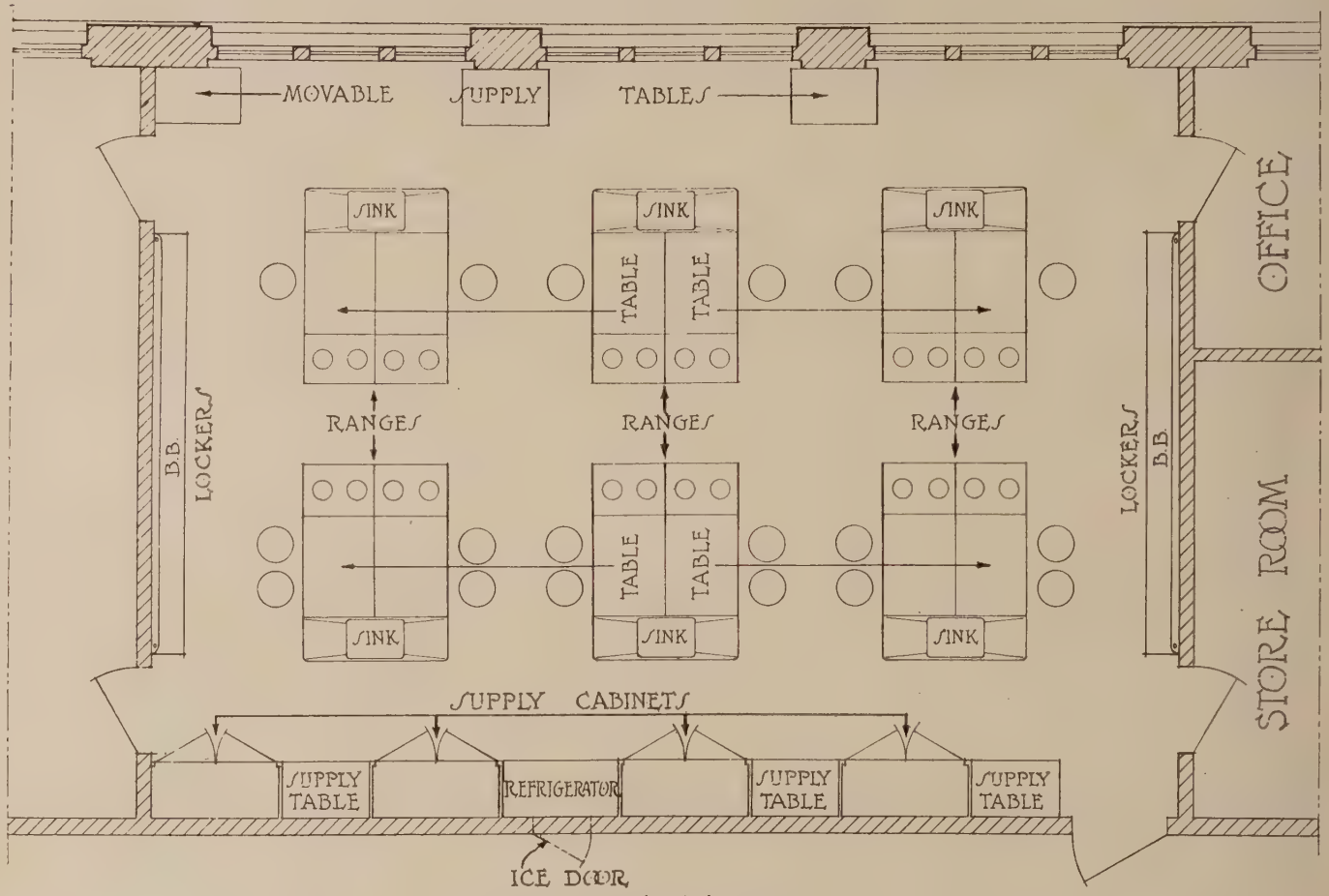
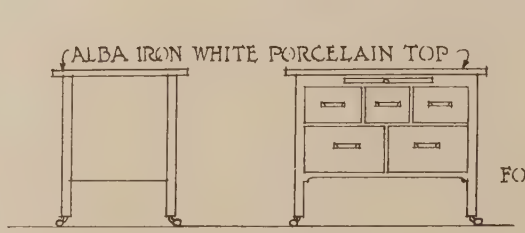
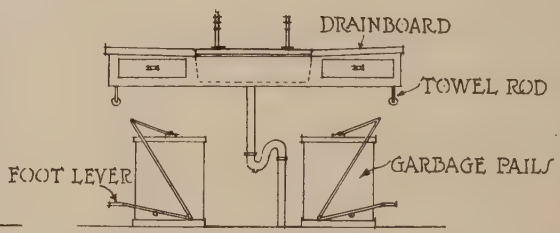


FIG. 403.





~ SUPPLY TABLES ~



~ SINK AND DRAINBOARDS, ETC. ~

SCALE:
1' 2' 3'

▲ AGNES FAY MORGAN ▲
▲ JOHN J. DONOVAN, ARCHT ▲
▲ COLLABORATORS ▲

~ ~ COOKING UNIT ~ ~

ARRANGED TO ACCOMMODATE 12 OR 24 PUPILS WITH COMPLETE UNIT TABLES IN A SPACE 26'-0" × 35'-6"

FIG. 404.

States. This arrangement, as shown in Figures 411 and 416, illustrates the common mistake of placing the pupils on the outside of the square, or horseshoe, with supplies on the inside, and sinks only at the corners or on the opposite walls. Such arrangement involves the maximum loss of time on the part of the pupils, with minimum exertion on the part of the teacher. Even the teacher may find the arrangement not altogether comfortable, however, since she is expected to stand within the fiery ring of stoves and ovens.

In the plan of the *unit desk* arrangement shown in Figure 403 each pupil has sufficient table space, 5 square feet, in which to keep utensils and to perform mixing and other operations, thus supplying all essentials of the table and cupboard usually found in the home kitchen. She has within 3 or 4 feet behind her a standard range, besides the convenient two gas burner stove in front of her on top of her desk. She has at her right or left hand a convenient sized sink supplied with hot and cold water. Behind her are the supply tables just as in the home kitchen she finds the supply cupboards. Every physical feature of the home kitchen is present, with the usual waste space and inefficient arrangement eliminated.

A more expensive but more efficient cooking arrangement unit than any heretofore commonly used is the type of *individual unit kitchen desk* shown in Figure 404 and consisting of table, with cupboard below, small range, sink and drainboard. One sink, two drainboards, a double table equipped with cupboards on two sides, and two small ranges, back to back, in a total floor space of 35 square feet supply complete equipment for two pupils. A cooking-room of the usual size, $25' \times 30'$, might accommodate six of these units and leave sufficient space for necessary tables, storage cupboards, and refrigerator.

It is desirable that at least one unit kitchen or family-sized kitchen be added to this equipment, as well as to the *unit desk* arrangement, just as storerooms and dining-rooms are usually added. Where space permits and older pupils are to be taught, enough unit kitchens should be included to accommodate either part or all of the class, with not more than three pupils assigned to one kitchen. When only part of the class can thus be accommodated the others are retained at the table desks. Any intermediate arrangement down to the minimum of one unit kitchen can of course be used. An excellent example of this scheme is shown in Figure 408.

2. *Placing of Unit Kitchens and Table Desks.*—The spatial arrangement of the table desks and unit kitchens when both are used is a problem of some difficulty, which will have to be solved in individual cases with reference to size of room, number of pupils in the class, lighting, and equipment. Figure 405 illustrates a scheme for a class of 24 in a space $32' \times 40'$ with windows on three or four sides. The objection to this plan lies in the fact that to gain access to two of the unit kitchens one must pass through one other unit kitchen. This is not a serious matter in practice, however, since all supplies are assumed available in each unit, and no passing back and forth is necessary. An assembly or recitation and dining table space add greatly to the value of this arrangement.

In Figure 406 an arrangement for smaller space with windows on two or three sides is shown. No dining table or recitation room is possible in this plan, but the unit kitchens are somewhat more satisfactorily arranged. The complete desk unit is not available here, because of lack of space for the ranges and extra sinks. This plan should work out well for smaller classes than those for which such an arrangement as is shown in Figure 405 is considered necessary.

For the more advanced lessons which may be given to girls of the ages 16 to 19 years, a cooking unit of a somewhat more elaborate type is required. In Figure 407 is shown an example of a suite of rooms which might be used for these classes. At the left of the plan will be noted the same table desk and unit kitchen combination advocated for use in the lower grades. The storeroom, refrigerator, and dumb-waiter connecting with other kitchens or lunchroom above are shown opening directly into an entrance service hall. Sometimes provision for this important detail of the convenient delivery of supplies is neglected.

3. *The Dietetics Laboratory.*—At the right of the plan in Figure 407 is shown the dietetics laboratory, which should be equipped with fume hood, acid-proof sinks, and possibly a small separate balance room for the carrying out of simple physiological and food chemistry experiments to illustrate the study of nutrition. The students' desks in this laboratory may be of the usual chemistry type, since very little cooking or so-called practical food work need be done here. Equipment of this sort is not ordinarily found in the home economics section of the high schools, or even in junior colleges. Its introduction is now both practicable and desirable if the food work is to be carried through these higher grades without deadening repetition of lessons taught earlier in the course. The work outlined for the dietetics laboratory cannot usually be advantageously done in the chemistry or physiology laboratories by the teachers of those subjects because of lack of time, training and interest on the part of the latter. Preliminary general courses in these subjects and in physics are necessary for the students of dietetics. By means of the universally interesting applications of these sciences to be

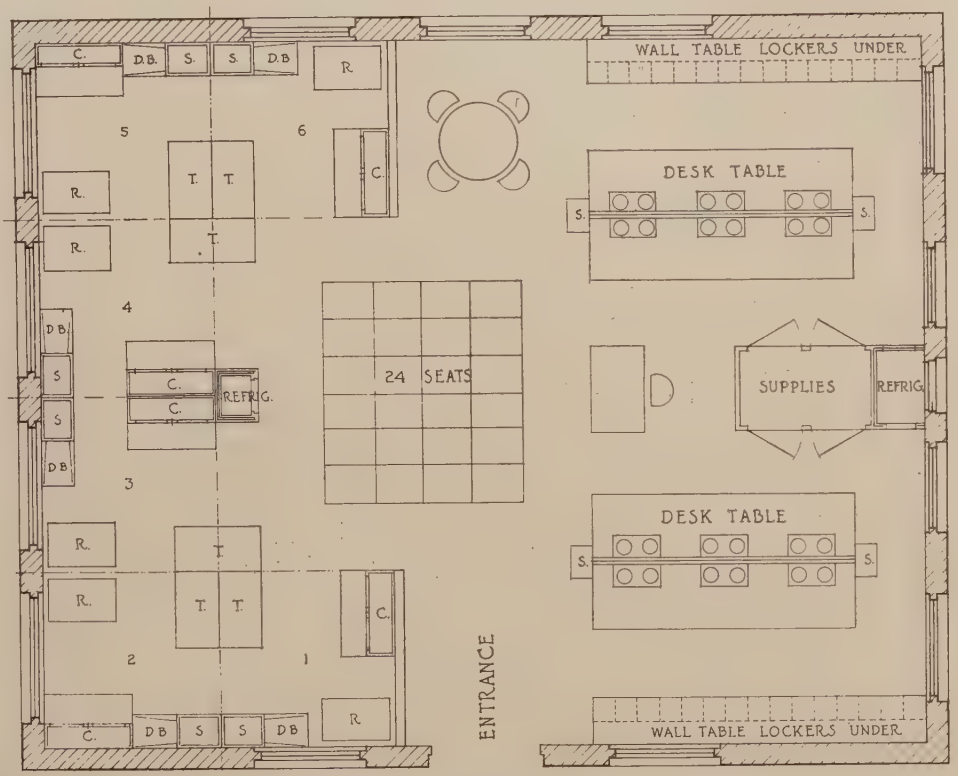


FIG. 405. ROOM 32'-0" x 40'-0" WINDOWS 3 OR 4 SIDES

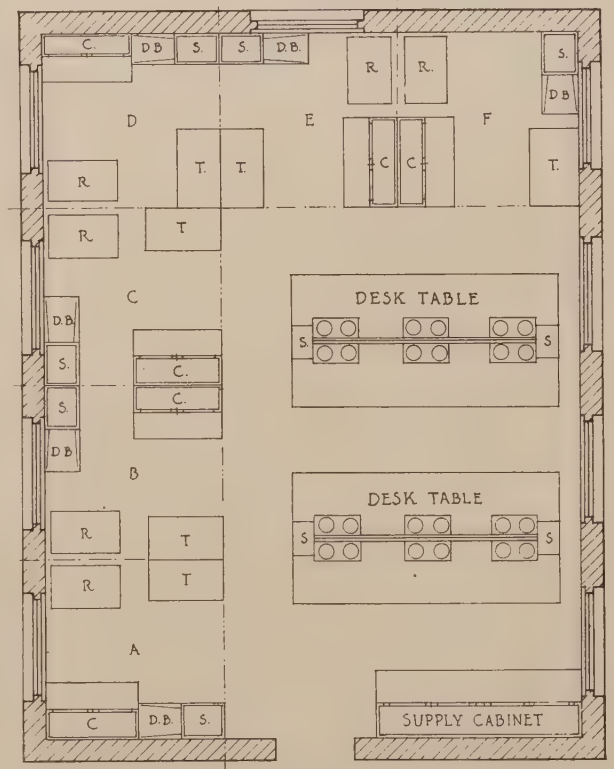


FIG. 406. ROOM 24'-0" x 32'-0" WINDOWS 2 OR 3 SIDES

RELATION OF UNIT KITCHENS TO THE DESK TABLES FOR A CLASS OF TWENTYFOUR

SCALE:

0' 5' 10' 15'

AGNES FAY MORGAN
JOHN J. DONOVAN, ARCHI
COLLABORATORS

FIG. 405 AND FIG. 406.

found in the study of nutrition and practical dietetics, new point and life may be given to the necessary training in the scientific method.

For large schools two suites such as those shown in Figures 401 and 407, placed one above the other, present all the elements necessary for full instruction of the secondary type in scientific and practical aspects of the cooking and serving of food, and the care of children and the sick. In Figure 401 a small hospital diet kitchen and fully equipped hospital or home bathroom are shown, for use in the preliminary training of nurses as now practiced in many large high schools.

4. *Arrangement of Unit Kitchens.* — Where more than one unit kitchen is provided there arises at once the problem of the size, kind of partitions, arrangement of furniture, and completeness of equipment of each unit.

(*a*) Size. The unit kitchen for use by not more than three pupils does not require more than 60 to 64 square feet of floor space. A larger space than this involves a waste of time in walking from sink to table to stove; a space much smaller than this involves crowding when more than one pupil is at work.

(*b*) Partitions. The placing of permanent wooden or other opaque partitions between the unit kitchens cannot be considered advisable, for a number of reasons. Permanent partitions of any kind prevent the flexible use of the units by experimental changing of size, and opaque partitions render difficult the oversight of the class by the teacher.

In some schools gas pipe railings, three or four feet from the floor, have been used to indicate the divisions of the unit kitchens. See Figure 409. Movable wooden, or better glass partitions mounted on frames and castors constitute an excellent means of separation. The available space may thus be divided into a larger number of small kitchens, or on occasion thrown into large compartments. These partition frames when built of wood should not be more than four or five feet high, so that some supervision by the teacher in adjoining kitchens may be possible. The glass partitions allow of higher frames if desired. Imaginary partitions may serve very well in some schools, particularly in the upper grades.

(*c*) Arrangement of Furniture. Each kitchen should contain a sink with one or two grooved drainboards, a stove or range, a storage cabinet, and a worktable. Where space is limited cupboards may be built in under the drainboards, Figure 409, and a cabinet base table, Figure 410, used, with elimination of the storage cabinet.

All of these articles, with the necessary exception of the sink, should be movable so far as possible, Figure 409. Even the stove in some cases may be changed in position at will. The object of mobility is chiefly that of affording practice for the pupils in the efficient arrangement of their kitchens and of accommodating in the same rooms classes of various sizes, and different kinds of instruction. Where it is impossible or undesirable to provide for movable furniture, some economy can be effected by the construction of built-in cabinets.

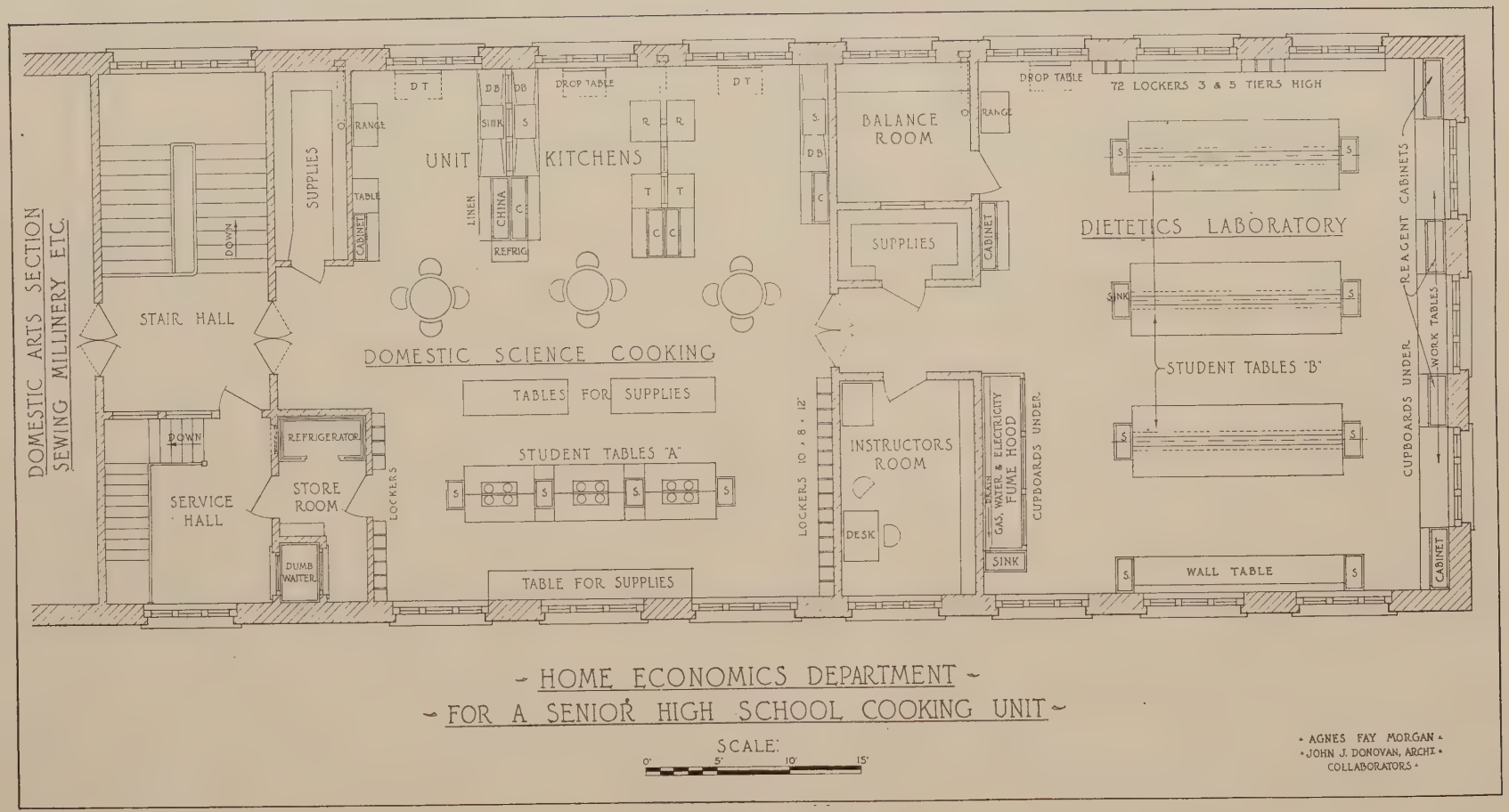
5. *Materials and Finish of Walls and Floors.* — In choosing the materials and finish for the interior surfaces of cooking units the first consideration should be sanitation and washableness. Trim metal is the most desirable but its cost is prohibitive compared with that of wood. The least amount of wood trim is desirable, for the finish of these rooms should approach that of the interior finish of hospitals where corners are rounded, bases coved, and chair rails when used have a very slight projection from the plaster walls. All wood trim such as baseboards, chair rails, picture moldings, casings and doors, frames, window sash, etc., should be given at least three coats of lead and oil paint and two coats of a high grade of flat enamel paint with the gloss only slightly dulled.

When the funds will permit, the chair rail should be omitted and the walls tiled to a height of five or six feet with an encaustic glazed tile $6'' \times 6''$ so as to have as few joints as possible, with a 6-inch sanitary coved glazed tile base at the floor. At the top of the tiling should be a glazed tile cap of simple design with the least necessary projection.

When tile cannot be used because of cost, Keene's cement plaster wainscoting is the next best material. When used it should not be marked off to imitate tile, as the markings serve no better purpose than so many recesses for the lodgment of dirt, grease, etc. The jointing defeats the purpose of the use of the materials and should not be allowed. The Keene's cement wainscot should be carried to the height suggested for tile and finished at the top with or without a cap, preferably the latter. The walls and ceilings above the wainscot should be of hard wall plaster troweled to a smooth, hard surface.

All Keene cement and plastered wall and ceiling surfaces should be painted with a high grade of washable wall paint, having no less than three coats, and then given a "satinette" enamel final coat. The color scheme may vary with the light accessible to the rooms, cream or ivory tones being as a rule the most favorable for all purposes.

Floors: The most desirable of all flooring for cooking units is cork tiling, as it is resilient, washable, and comfortable to work upon. Here again the cost is an element likely to limit its use. The next best are tile, composition, or cement flooring in order. Cement and tile,



HOME ECONOMICS DEPARTMENT
FOR A SENIOR HIGH SCHOOL COOKING UNIT

SCALE: 0' 5' 10' 15'

AGNES FAY MORGAN
JOHN J. DONOVAN, ARCHI
COLLABORATORS

FIG. 407.

however, require linoleum strips or sections in the working divisions. The advantage in the use of these materials with a sanitary cove base of similar materials is that by installing deep sealed floor drains the floors may be hosed freely.

Wood floors are and will be most generally chosen, as they are the least expensive. Consequently, the harder and more durable woods should be selected. Maple is by far the best of all woods for such flooring. Next in order are birch, northern pine, Douglas fir, and southern pine.

The finish of wood floors should be of a high grade floor varnish, at least three coats. Usually the wood floors of cooking units are treated with a prepared floor oil, but the low kindling temperature of such floor dressings makes their use dangerous, particularly where there is so much use of fuel.

6. *Working Tables.* — A number of arrangements of the continuous table desks in the cooking unit are possible, the two most frequently used being the hollow square and the parallel long tables. In Figure 403 is shown a modified hollow square with the objectionable features eliminated. Figure 412 illustrates another modification of this arrangement, two long tables with students facing each other, and space between for the teacher. The supply tables and ranges are placed then back of the students and at the sides of the room. This arrangement is probably the most economical of space of any that has been devised. In the dietetics laboratory in Figure 407 are shown the conventional double tables long found practical in chemistry laboratories. Any arrangement based on a stationary position for the teacher is not as likely to be serviceable as one in which the teacher is expected to move about from one pupil's desk to another, for constant supervision and assistance in the mechanical operations taught.

Whatever the placing of the tables, there should always be allowed sufficient working space for each pupil. This should be not less than five square feet of unobstructed table top, the depth usually being not over 24 inches, the width 30 inches.

If ordinary movable kitchen tables are used, as they often may be, not more than two pupils, preferably only one, should be assigned to each table, 3′ 6″×2′ 3″ in size. When these tables are used the difficulty arises of providing suitable cupboard space for the individual utensils. This difficulty may be solved by the use of cabinet type tables such as those illustrated in Figure 410. These cabinet type movable tables might well be used in the individual unit kitchen desk illustrated in Figure 404. There are several excellent tables of this kind on the market, which may be purchased in communities where it may not be possible to have them built to specifications. In furnishing the large unit kitchen this type of table is not required in most cases since cupboards or cabinets are usually included in the furnishings.

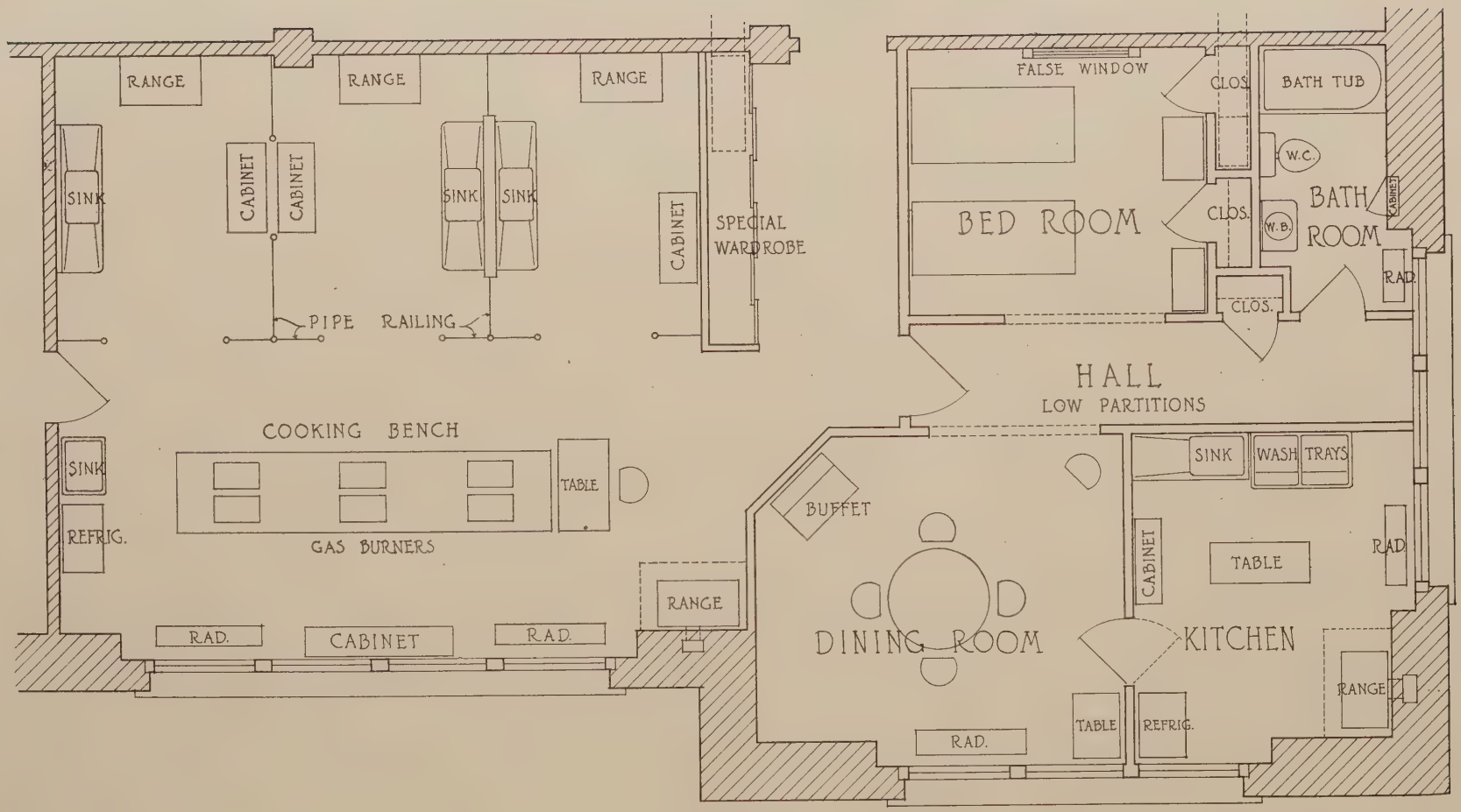
Design of Table Desk Cabinets. Where continuous table desks are used, as illustrated in Figures 401, 405, 406, 407, 412, the drawers and cupboards built in below must be designed with special attention to the number of utensils assigned each outfit, and to the number of different classes using a given table. One or two open shelves beneath the top, one drawer and one shelf, several drawers, or a drawer and cupboard are the variations that naturally suggest themselves. In Figure 414 is shown the front elevation of a type of table desk well adapted to use for dietetics or other advanced course in which a certain amount of individual apparatus may have to be assigned. Each unit of this table contains four individual lockers, one common locker, and one common drawer. Four students in different sections might thus have an individual assignment of apparatus with a certain amount of materials and utensils in common in the unlocked drawer and cupboard.

In Figure 415 are shown the front elevations of two other less elaborate arrangements, the one alternating an open space with a drawer and a cupboard, the other showing a tier of four drawers, then a single drawer, then a drawer and cupboard, a single drawer again, and the whole repeated. In Figure 416 an arrangement similar to the simpler one outlined in Figure 415 is shown. Other designs may be used, such as that of a roller drop over the cupboard below the drawer, Figure 413, or two full length double drawers, one of them sufficiently deep to serve as cupboard, illustrated in Figure 417.

A good clear piece of maple or similar wood from 18″×12″ to 24″×24″ in size with drawer pull is usually provided for molding or bread board, and fitted into a space immediately under the table top in each pupil's working area. Well-sized heavy pieces of canvas treated with a light dressing of paraffin or oil may be used instead of these boards if occasion demands.

Materials for Table Tops. Sugar pine, maple, or any other serviceable hard wood may be used for the table tops, and may be finished in a variety of ways. If left unvarnished or painted, considerable time and labor must be expended in keeping the wood scoured, a necessity not desirable under any conditions. Painting, enameling, staining, and varnishing are the alternatives with wooden tops.

A number of composition materials, such as alberene or germanstone, are available for table tops, and are easy to care for, but are often absorbent of grease and other substances. Cement tops have been used in some schools to good advantage.



PLAN OF DOMESTIC SCIENCE DEPARTMENT IN ELEMENTARY AND INTERMEDIATE SCHOOL TAKEN FROM DRAWINGS OF PUBLIC SCHOOL #29, N.Y. CITY. Mr C. B. J. SNYDER, ARCHt

SCALE:

0' 5' 10' 15'

FIG. 408.

Vitrified tile, glass, marble, lava have all been used with varying success. The glass, marble, and lava crack with heat, and are destructive of glass and china utensils; the tile, being set in small pieces, collects dirt, and wears out in the seams.

Any table top chosen should be easily cleaned, non-absorbent, not warped or cracked by heat, fireproof, and resistant to acids and alkalis. Any good grade of wood, such as sugar pine, treated with acid-proof liquid and properly protected by metal under the stoves is probably the best and most economical choice to meet most of these requirements.

Heights of Tables. The height of a table adjusted for standing work for the medium tall adult woman, 66 inches in height, should be about 33 to 38 inches. The American girl 11 to 14 years old, the 7th, 8th, and 9th grade ages, averages 53 to 59 inches in height, and should therefore work at a table not more than 23 to 29 inches high. Where tables are constructed for individual classes of known average height better adjustment can naturally be made. For the senior high school classes, the tables may be of standard adult height, or in the unit kitchens and unit kitchen desks, varied an inch or two so that pupils of various sizes may be assigned to working tables best suited to their needs.

Some kind of seat should be provided for each pupil, since many of the operations to be carried out are long and tedious. These seats may be either unattached stools, or seats attached to the side of the table desks by hinged brackets. If space is provided under the table top for the seats to be swung or pushed out of the way when not in use a neater and more usable laboratory results. If separate stools are provided their legs should be tipped with rubber or at least with metal glide caps. In any case the height of the seat should be carefully adjusted to the average height of the pupils as well as to the height of the table. With tables 31 inches high, the stools should measure 19 inches, or in general a difference of 12 inches should be maintained between the two.

7. *Stoves.* — The type of stove used in the school must be chosen with reference to the fuels in use in the community. Where several kinds of fuel are accessible, stoves constructed for use with each should be available in the school. Wherever possible small individual gas stoves should be provided for the general class instruction in principles, although single examples of others, such as oil, coal, and electric ranges, should be available for the teaching of the peculiar technique involved in their use, and for comparisons of costs and speed of cooking.

Electric Stoves. If electric stoves are used, small hot plates and double ovens may be used on the table desks, and an electric range in the unit kitchens or unit kitchen desks. Individual meters should be attached to these devices, for the cost of electric cooking is usually large enough to warrant this special emphasis on the study of economy in its use. In Figure 418, showing part of the electrical equipment in use in the University of New Mexico, these individual meters may be seen.

Gas Stoves. Single or double burner gas plates are usually attached immovably to the back of the table desks, over some sort of fire-resistant material. These small stoves are useful for class instruction in principles, taking the place of the Bunsen burners used for a similar purpose in other science laboratories. For various excellent types of these small stoves see Figures 416, 417, 419.

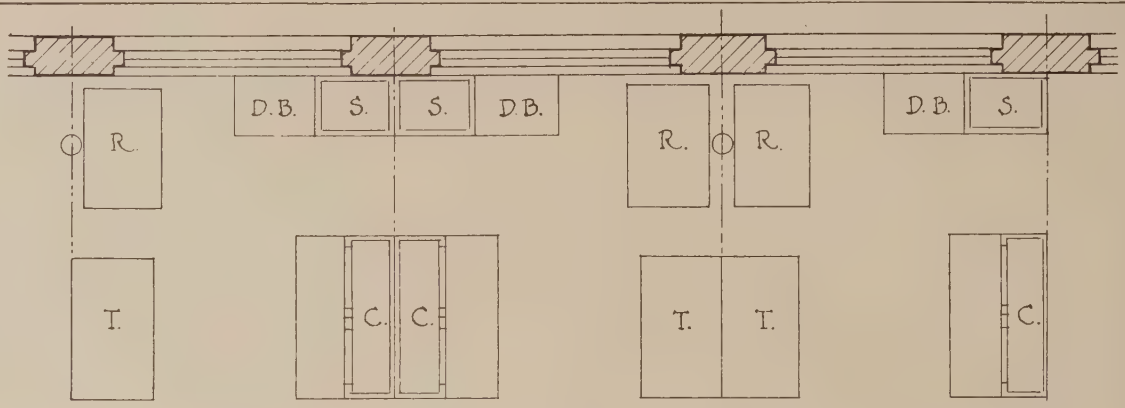
With properly guarded flexible metal tubing connections, however, these gas plates may be made movable, and the working space on the desk top more variously usable. The gas plates must then be attached to stiff magnesite boards, unless a strip of zinc or copper is placed across the back of the table top, for fire protection. This arrangement, as well as the more usual fixed burner type, is illustrated in Figure 420.

For most communities, gas is still the cheapest, cleanest, and generally most efficient fuel for cooking. The ranges used in the unit kitchens or unit kitchen desks should therefore, if possible, be chosen from among the excellent varieties of gas ranges now on the market, and as many different types should be installed as there are kitchens to equip, for good points of various sorts are exhibited by many of them. For the *unit desk* arrangement illustrated in Figure 403 and the *unit kitchen desk* illustrated in Figure 404 the small 3 or 4 burner range with oven below should be chosen, in order that space may be saved and supervision by the teacher made easier. In the larger unit kitchens the larger ranges with oven above may be installed.

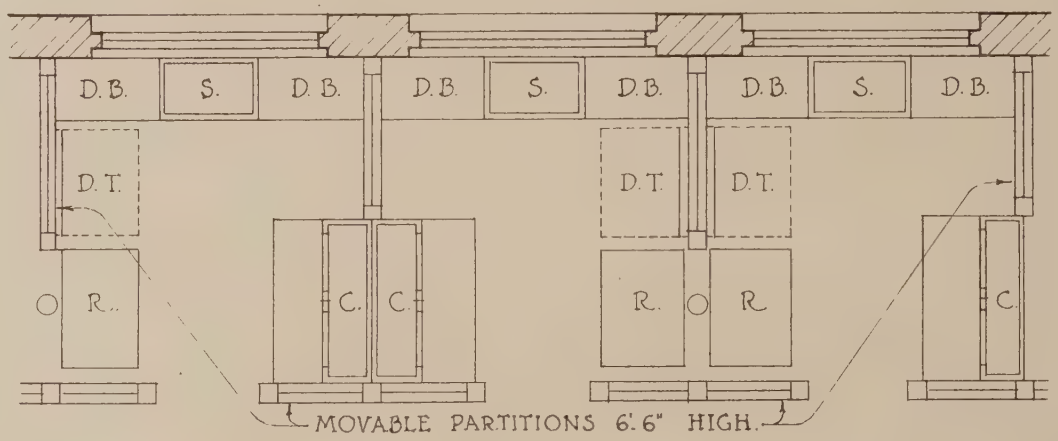
The gas meter should be conspicuously placed on the wall of the cooking laboratory, so that the pupils may be taught to read and observe it. See Figure 416. In high schools and junior colleges at least one stove besides should have an individual meter for experimental purposes.

A water and electric meter as well should be available for instruction in reading and computing of costs in some part of the home economics school equipment.

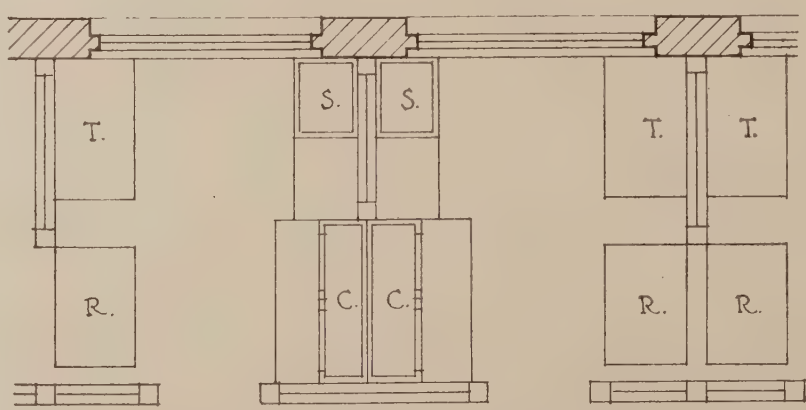
Oil, Coal, and Wood Stoves. If coal or wood is used at all in the community, at least one stove of these types should be found in the laboratory, and indeed several different types, if no other fuel is available. Simple 4- or 6-hole ranges are best for the instruction in family-size cooking, with single or double oil burners for the table desk practice. Small portable ovens should be



IMAGINARY PARTITIONS, MOVABLE FURNITURE.



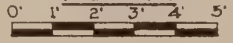
MOVABLE WIRE GLASS PARTITIONS & FURNITURE, CUPBOARDS UNDER THE DRAIN BOARDS.



LEGEND

C. CABINET
D.B. DRAIN BOARD
D.T. DROP TABLE
R. RANGE
S. SINK
T. TABLE

SCALE:



WOOD OR GLASS PARTITIONS, BUILT IN CABINETS.

UNIT KITCHEN ARRANGEMENTS.

FIG. 409.

provided for use with the latter as well as with the gas plates described above. It may be advisable where both coal and gas are commonly used to equip the unit kitchens with good combination coal and gas ranges.

If coal, wood, or oil for use with these stoves are kept in the cooking-room, fireproof boxes should be provided for them.

Hoods. It is an excellent precaution wherever possible to install metal hoods or canopies over the larger ranges, the outlets being connected with the usual ventilating shaft. The installation of these hoods in the unit kitchens, unit kitchen desks, and lunchrooms should help to solve the problem of the ever present odors so often an objectionable feature of cooking instruction in the schools. Moreover, if these canopies are constructed of steel, copper, galvanized or Russian iron, well insulated by asbestos from any wooden wall surfaces, they lessen considerably the fire hazard. Where special care to avoid obstruction of the light is necessary, wire glass should be substituted for the metal.

8. *Sinks.* — (*a*) Standard porcelain sinks of the usual kitchen size, 1′ 6″×2′ 0″, should be used in the unit kitchens and unit desks, (*b*) smaller sinks at intervals of 4 to 8 feet let into the long table desks, or (*c*) small sinks and copper or other metal-lined trough. In Figures 405, 406, 414, and 420 sinks of type (*c*) are illustrated, the detail of which is given in Figure 414. An arrangement of type (*b*) is shown in Figures 420 and 412; type (*a*) in all the unit kitchens. In Figure 419 it may be noted that although the sinks provided are numerous and of excellent design the mistake of omitting drainboards has been made. Double inclined and grooved wooden drainboards should be attached to all the larger sinks in the cooking-room, being omitted only in the case of the small sinks and troughs, types (*b*) and (*c*) above, used with certain kinds of long table desks. In the latter case the sinks are designed to be mere catch-basins below the water faucets, not to be used for dishwashing. Other materials, such as germanstone or similar compositions, porcelain, or zinc, are sometimes used for drainboards, but for the same reasons given in the discussion of table tops prove less satisfactory than wood. Where space for a drainboard is not available, small movable porcelain top tables should be placed near the sink.

In order that the time of pupils and teacher may be conserved, all dishwashing sinks should be piped with hot water, and whenever possible the table desks should be similarly equipped. In the unit kitchens, unit kitchen desks, diet kitchen, and dietetics laboratory, hot water should be available over each sink. In order to provide this a suitable type of water boiler should be installed in the cooking unit, preferably in a hall or separate inclosure with all precautions against fire risk, or hot water from the school steam plant may be used if available.

A short nickeled, tin, or glass towel rod should be attached to some convenient part of the individual desk. It may be placed on the inner side of a cupboard door or the under side of the table top, ledge or sink drainboard. See side of sink in Figure 404. This is for use during the lesson, when constant employment of hand and dish towel is necessary. A larger towel drier or rack of the collapsible wall, laundry, horse, or inclosed steam types should be provided for the drying of towels between lessons. It should be candidly stated, however, that the minimum of time spent in laundering towels

Fig. 410. — Movable Cabinet and Table with Alba Iron White Porcelain Top.

should be exacted of pupils and teacher, since with a reasonably large supply and frequent consignments to a local laundry the towels can be maintained in a more sanitary condition, and school time saved for other more profitable exercises. For instruction in laundering processes, an occasional lesson in towel-washing should be given.

The rolls of paper towels now so common may often be utilized for hand washing with resultant saving in laundry. These rolls should be placed over each large sink, with a waste basket for receiving the shreds on the floor beneath.

9. *Storage Cupboards and Cabinets.* — If sufficient storage space in drawers and cupboards be supplied each student in the desk tables, a smaller number of general cupboards will need to be provided. Usually some cupboards with shelves and drawers should be built into the walls, to store extra utensils and supplies not distributed in the individual desk space, or in the cabinets of the unit kitchens. If possible, all shelves

should be inclosed, and in some cases, at least, glass doors are desirable.

If sufficient wall space for the construction of these cupboards is not available in the cooking-room a separate pantry should be provided. See Figures 401 and 404. In any case the shelves should be either movable or carefully planned beforehand for certain uses. The drawers are more useful if their contents also are planned for, and thin wooden partitions properly distributed within them.

There are several excellent movable kitchen cabinets on the market equipped with drawers, bins, shelves, and boxes, which may sometimes prove more economical and efficient than built-in appliances. Their best feature lies in their being easily moved about. In Figures 421 and 422 are shown some examples of these cabinets. Usually these articles are best confined to the unit kitchens, and a simpler arrangement of drawers, shelves, and bins built into the wall for the general use of the teacher and the whole class at the desk tables.

Supply Shelves. Shelves for supplies may be made of plate glass or of wood covered with a good washable enamel or with well-secured oilcloth. All shelves and drawers need frequent washing and should be constructed and finished with this in mind.

Large quantities of food supplies are no longer necessarily accumulated in school kitchens, even where family-size portions of food are prepared, for the saving in cost is not now so great as formerly when large amounts are purchased. Modern food economics points towards the more complete segregation of food storage in warehouses under optimum conditions, and away from family storage and preservation. This tendency reflected in price removes the former advantage obtained by large quantity buying, with its attendant danger of loss by spoilage. Overlarge storage capacity should therefore no longer be considered a necessary part of the school cooking equipment. The large flour, meal, and vegetable bins formerly used should now be replaced by 10, 25, or 50 pound capacity tin boxes or stone crocks and plenty of narrow shelves for package goods. Foods which can be kept in jars should be placed in well-labeled 1, 2, or 3 quart wide mouth glass jars for protection against dust and vermin. These jars may be placed on narrow open shelves on the side walls, just as on an opposite wall should be placed the jars and bottles of the simple chemicals needed for the demonstration of the composition and properties of foodstuffs.

Supply Tables. Large plain kitchen tables, with or without drawers and cupboards below, should be used for setting out, convenient to the students' reach, the supplies needed for a given lesson. These tables, not less than $2' \times 3'$ in size, should be equipped with large ball-bearing castors, and covered with heavy oilcloth, vitrolite glass, or porcelain tiling. Since every student should find herself within two or three steps of such a supply table, the number of these tables should be about one to each 4 to 8 students. If extra cooking or chemical equipment be needed for a given lesson, this too may be placed on the supply tables beforehand. The proper use of such tables may add somewhat to the work of preparation by the teacher, but can be made to increase very greatly the quantity and effectiveness of work done by the student in a short laboratory period. Indeed the habit of thus systematically preparing for the performance of any kitchen task is not the least valuable lesson to be learned by the cooking class.

In the unit kitchen desks a two-gallon enameled garbage pail with cover, operated by a foot lever, is a useful part of the equipment. See Figure 404. Similar pails should be placed under the large sinks or at the ends of the desk tables. Sometimes small earthen garbage jars, with or without covers, may be used to advantage as part of the individual desk equipment.

Refrigerators. An indispensable feature of the cooking unit is the refrigerator. This may be built into the wall, with an ice compartment which may be reached from an outside hallway, or better may be of the ready-built movable type which is furnished by refrigerator concerns in a large variety of styles and sizes. The size must be governed, of course, by the number and size of the classes which will use it, although an ice compartment holding less than 50 lb. of ice is usually expensive and inefficient. The style should be simple, washable in all parts, and readily disassembled for inspection and study. Porcelain or enamel lining is preferable to galvanized steel. The refrigerator should be placed close to an outside door or in a service hall for convenience in delivery of the ice. In addition to the refrigerator a cooling closet of generous size is an excellent feature of the cooking unit.

10. *Utensils and Apparatus.* — Several types of equipment for food manipulation should be provided. These are (*a*) the individual desk table equipment; (*b*) the unit kitchen or unit desk equipment; (*c*) labor-saving devices; (*d*) chemical or scientific equipment; (*e*) hotel or lunch-room equipment; (*f*) hospital diet kitchen equipment.

For all the cooking utensils a few general words may be said as to material, design, and number.

A variety of materials should be used for purposes of comparison and study, such as saucepans, double boilers, pie-pans, dishpans, etc., of gray, white, and blue enamel ware, aluminum, cast aluminum, tin, nickel, and galvanized iron. Each unit kitchen or unit kitchen desk should be equipped with a different type of ware,

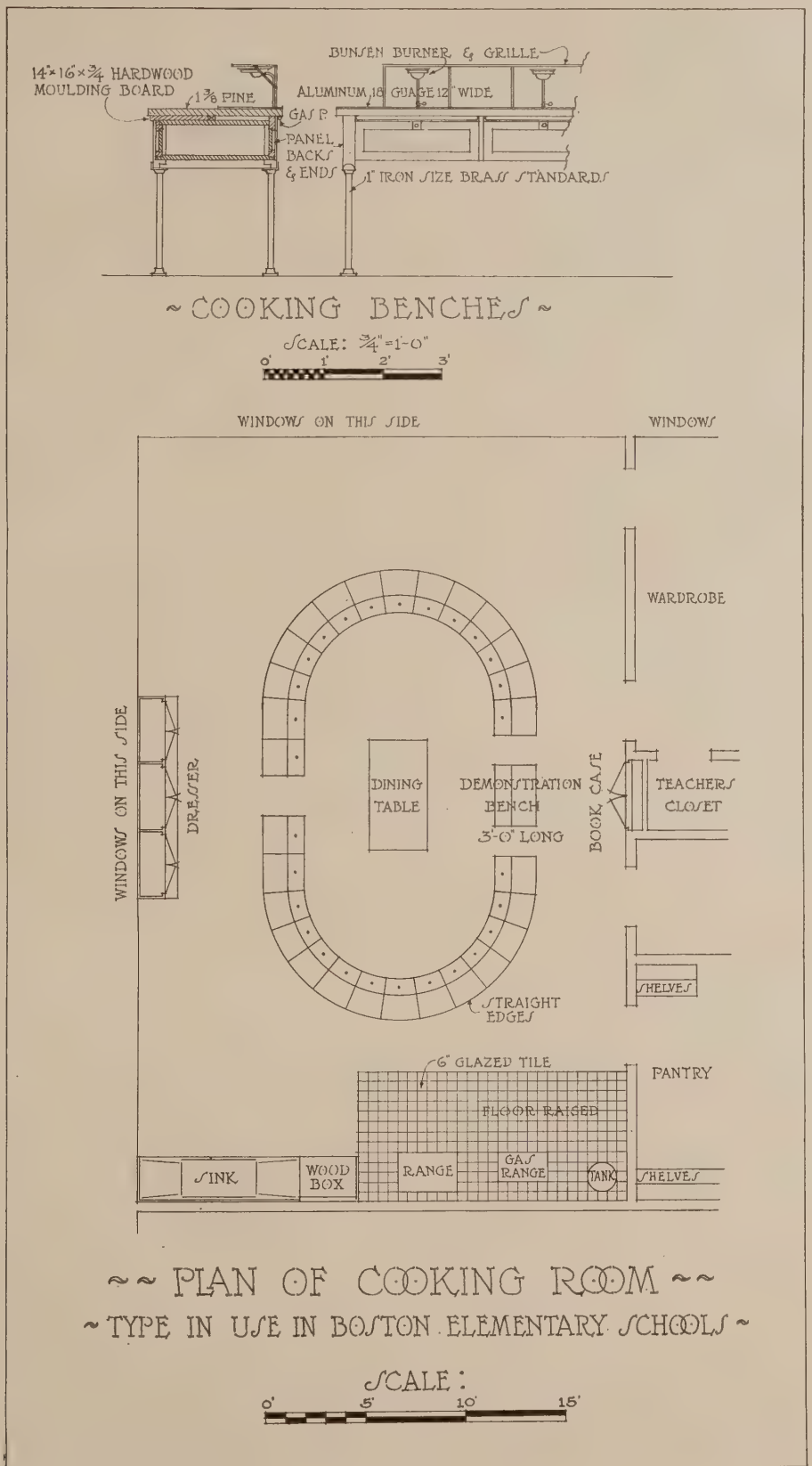

14"×16"×¾ HARDWOOD MOULDING BOARD
1⅜ PINE
BUNSEN BURNER & GRILLE
ALUMINUM 18 GUAGE 12" WIDE
GAS P
PANEL BACKS & ENDS
1" IRON SIZE BRASS STANDARDS
~ COOKING BENCHES ~
SCALE: ¾"=1'-0"
0' 1' 2' 3'
WINDOWS ON THIS SIDE
WINDOWS
WARDROBE
WINDOWS ON THIS SIDE
DRESSER
DINING TABLE
DEMONSTRATION BENCH 3'-0" LONG
BOOK CASE
TEACHERS CLOSET
SHELVES
STRAIGHT EDGES
6" GLAZED TILE
PANTRY
FLOOR RAISED
SINK
WOOD BOX
RANGE
GAS RANGE
TANK
SHELVES
~~ PLAN OF COOKING ROOM ~~
~ TYPE IN USE IN BOSTON ELEMENTARY SCHOOLS ~
SCALE:
0' 5' 10' 15'

FIG. 411.

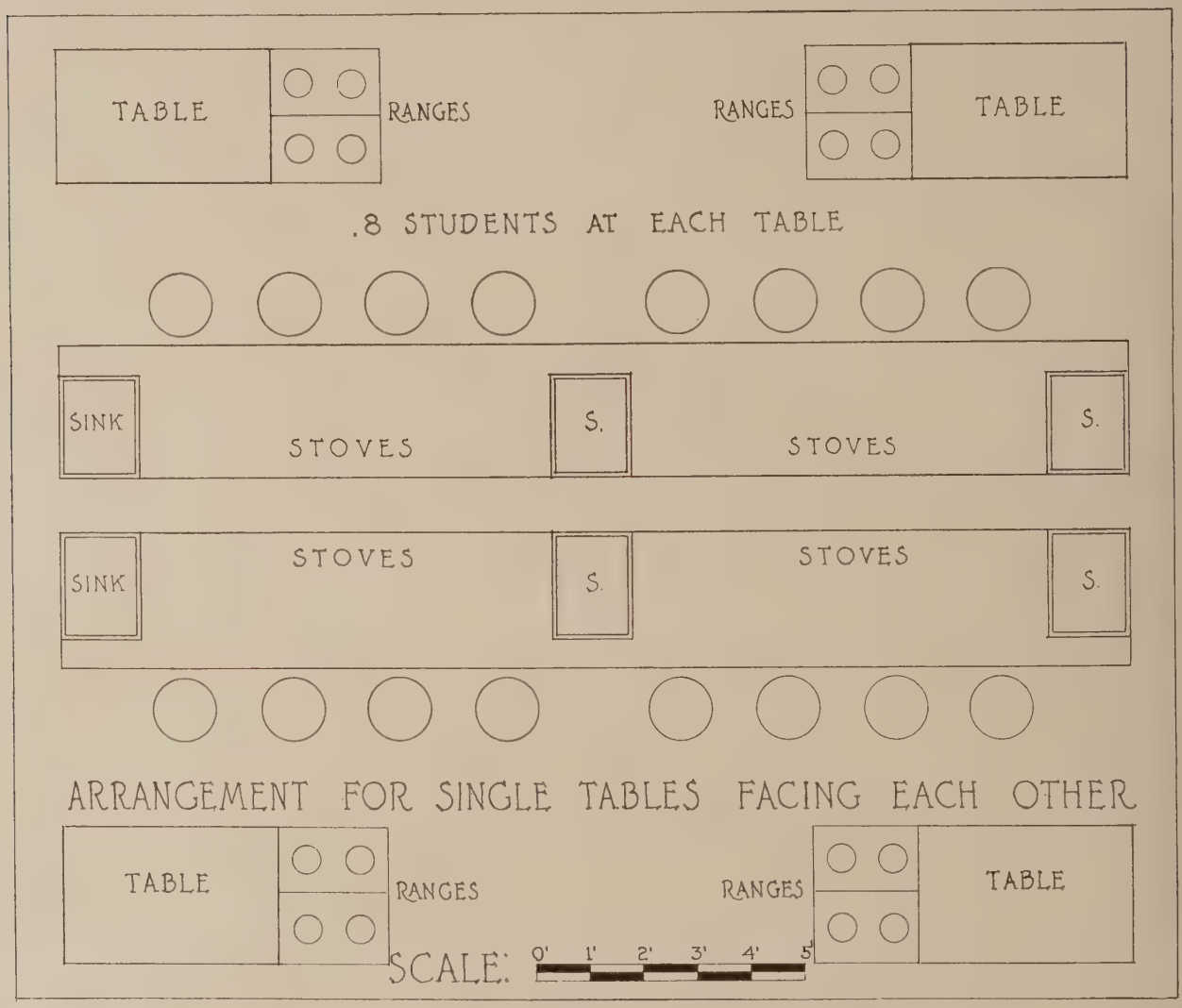


Fig. 412.

none that is efficient, safe, and properly constructed being omitted. Many teachers and housekeepers find the aluminum ware particularly convenient because of its lightness, durability, and high heat conductivity. American granite ware, gray or blue, and the Swedish white enamel ware are found also to be light, easily cleaned, and of lower original cost. When the granite ware begins to chip seriously it should be discarded because of danger of antimony poisoning, difficulty of cleaning, and unevenness of heating. The heavy black iron kettles of the last generation need not be represented in the modern school kitchen, nor the copper ware which is now practically unobtainable for general use. Only the actually used wares of to-day should appear, but these in all of the approved types.

Simple designs should be chosen for all cooking utensils; those with no sharp corners, or cracks, rolled-over edges, or unnecessary indentations are best. The stream-line design is applicable to cooking utensils as well as to automobiles, and provides most surely against the accumulation of dirt.

(*a*) The Individual Desk Table and General Class Equipment. The number of utensils provided for each pupil should be kept small enough to avoid cluttering the table, waste of time in cleaning, or the cultivation of an undesirable dependence upon specific tools. At the same time the variety should be sufficient to prevent waste of time and material in cooking operations.

A certain number of utensils should thus be available in the drawers and cupboards assigned to each student, including a small amount of the simplest chemical apparatus. In addition to such articles as trip balances and thermometers, a microscope should be stored in the wall cupboards or supply room ready for occasional use. In the same manner extra cooking equipment must be kept on hand in the cooking unit, ready for use on

Mr. John J. Donovan, Architect.

FIG. 413. — COOKING-ROOM, OAKLAND TECHNICAL HIGH SCHOOL, OAKLAND, CALIFORNIA.

occasion. This extra equipment consists largely of bread-baking, fruit-canning, jelly-making, freezing, and similar appliances.[1]

(*b*) The Unit Kitchen Equipment. In the movable cabinet and table drawers of the unit kitchen should be stored family-size cooking equipment of rather large variety. Each kitchen may be equipped with a different ware if desired, but care should be taken that all necessary articles are supplied in each. The setting out of the necessary supplies and of extra utensils should seldom be done by the teacher preceding a lesson in family-size food or meal preparation in the unit kitchen. All materials and utensils should be put away in their proper places in the kitchen and the pupils expected to get them out and do the work in an orderly and efficient fashion.[2]

Family-size Cooking Utensils. It would scarcely be sufficient, as might be thought at first glance, to combine all the apparatus listed under individual desk and general class equipment in order to indicate the furnishing of the family-size kitchen. The difficulty is that in many cases larger size utensils must be used, as well as certain mechanical devices, the use of which is not required in the analyzed or idealized processes carried out at the desk tables during instruction in the principles of food selection and preparation. Examples of the latter are the bread and cake mixers, various types of egg beaters, mayonnaise mixers, etc. The different purposes for which the unit kitchen practice operations are prescribed must be kept in mind in choosing utensils for these parts of the cooking laboratory.

Individual Serving Outfit. With the addition of a small outfit of serving dishes and silver, valuable practice in meal serving by small groups of pupils, or even by one at a time, can be carried on in the unit kitchens. Small movable dining tables may be placed in the space

[1] For complete lists of utensils required, see *Equipment for Teaching Domestic Science*, by Helen Kinne, Whitcomb and Barrows, 1909.

[2] See Iris Prouty O'Leary — *Cooking in the Vocational School as Training for Home Making*, U. S. Bureau of Education Bulletin, 1915, No. 1, whole No. 625.

directly in front of the open kitchen as shown in Figure 423, or the kitchen table may be converted for the purpose into a temporary dining table. With this arrangement every article of food cooked may be served, at least by mock service.

The dishes and other table ware used for this purpose should be of a uniform pattern so that when collected for larger meal service they may serve for the formal dining-room equipment.

The unit kitchen desk, because of limited cupboard space, naturally cannot be equipped with as large an assortment of utensils as the larger kitchen, but may be provided with a considerably larger outfit than that described for the individual desks in the long table or class desks. In any case the latter may be looked upon as the minimum and the unit kitchen equipment as the optimum, any possible compromise being struck between the two.

(*c*) Labor-saving Devices in the Kitchen. (1) Electrical appliances. If electric current is available, at least one type of electric toaster, thermostat oven, coffee urn, and water heater should be included in the cooking equipment. Special attention in high school continuation classes may thus be directed towards the rapid preparation of the small family breakfast or lunch. The use of the small electric motor for beating eggs, salad dressing, turning the freezer, the sewing machine, the buffer, etc., should also be taught.

(2) Fireless cookers. A number of simply constructed fireless cookers are on the market, and numerous directions are available for amateur construction of these labor-saving devices. At least one example of this piece of apparatus should be found in every school kitchen.

(3) Pressure cookers. The small aluminum pressure cooker of vaselike shape is still probably the most satisfactory article for general use. Its shape and size are both poorly chosen for use in canning, however, so that if much canning work is to be done, as in country schools, this cooker should be discarded in favor of the square steam canner. Some type of pressure cooker should be available even in the elementary school equipment for demonstration of the processing of canned foods, sterilization for hygienic purposes, the rapid cooking of tough meats and otherwise usually long-process foods, as well as of the relation between pressure and boiling temperature.

(4) Dish-washing devices. Although no efficient dish-washing machine for a small number of dishes and a small expenditure of money is yet available, there can be little doubt that simple devices to decrease the drudgery of dish-washing will continue to be made, and their use should be taught. A few articles of this kind are: well-designed dish drainers, mops, plate scrapers, chain pot scrubbers, hose and spray attachments for rinsing dishes, rubber mats and stoppers for sink and drainboard, sink strainers, soap shakers.

If hotel or lunch room trade classes are held, practice in the manipulation of a modern dish-washing machine should be provided as well.

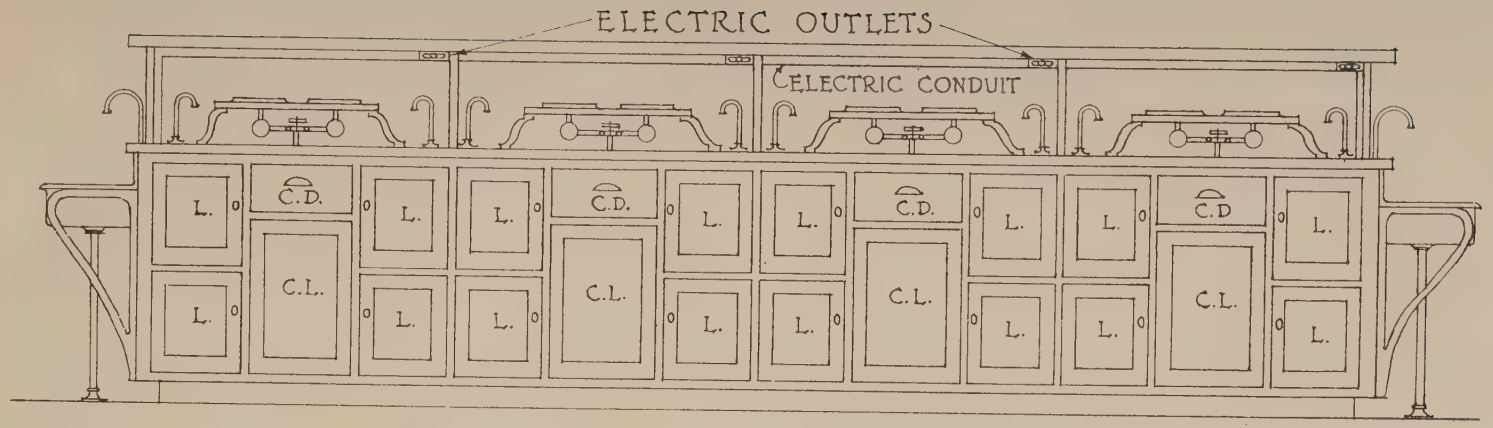
(5) Wheel tray. A thoroughly mobile wheel tray equipped with large ball-bearing rubber-tired castors with two trays and perhaps a drawer, is an excellent appliance for use in the school kitchen. If a formal meal is to be served some such wheeled device is almost indispensable. The article may be made out of any ordinary small table by adding the wheels as shown in Figure 423, but is preferably of metal, for durability and ease in cleaning. This tray is not to be confused with the pleasing bit of dining-room furniture known as the tea wagon. The latter may be loaded in the pantry or at dining-room door from the tray, for it is usually not constructed for the humble utilitarian purpose to be served by the wheel tray.

(*d*) Chemical or Scientific Equipment. For the proper development of an experimental basis for the study of the selection and preparation of food, as well as for the illustration of scientific principles by means of such study, a certain amount of simple chemical apparatus is desirable for high school classes. Some of this apparatus should be stored in the individual desks and the students made responsible for it. Some of the apparatus should be stored in the teacher's cabinets and distributed to the students only at the times when it is to be used. In the former list are included a few test tubes, filter funnels, beakers, flasks, test-tube brush, filter paper; in the latter, balances, thermometers, Bunsen burners, stands and clamps, condensers, pipettes, burettes, and reagents. Without such equipment the illuminating and interesting tests for the various characteristic food compounds cannot be made.

(*e*) Hotel or Lunch Room Equipment. One type of trade requiring professional training, which may well develop out of home economics education as commonly understood, is that of cafeteria or lunch room manager or worker. To make a proper field for practice and supervision in this training the school lunch room or cafeteria should be either under the direct charge of the home economics teacher or under a trained manager willing and able to coöperate with the department.

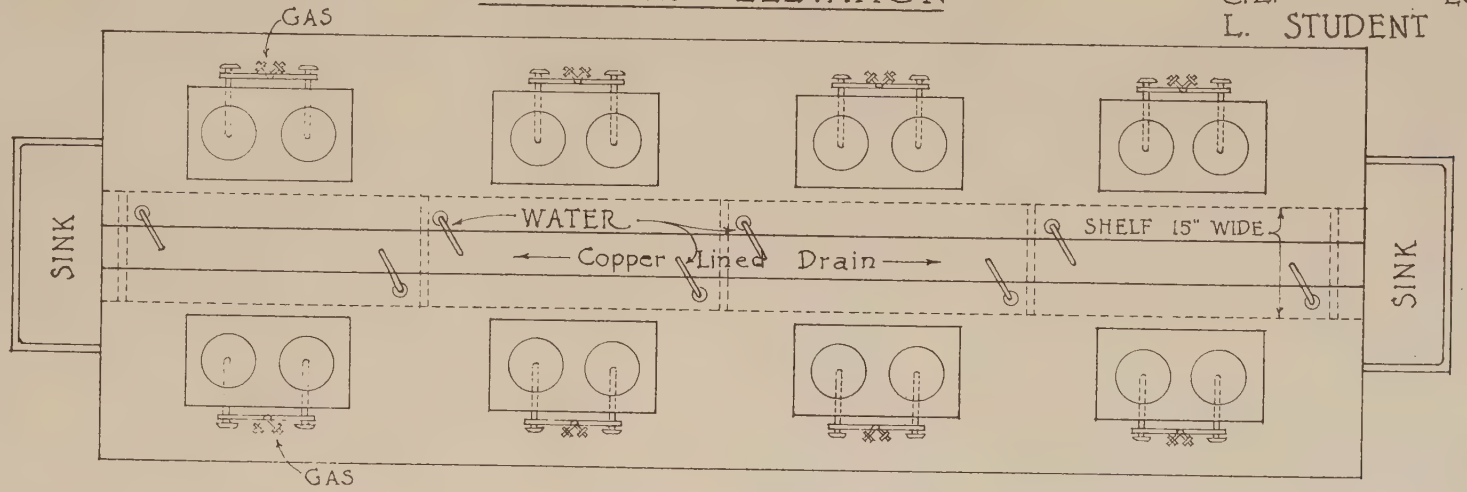
It may be assumed to be unwise, if not disastrous, to attempt such a scheme as that tried in the Gary Schools [1] and elsewhere, in making the school lunch room dependent upon the output of the cooking classes, and the cooking teacher and the pupils responsible, with very

[1] Survey of the Gary Public Schools. *Household Arts*, by Eva W. White, 1918.



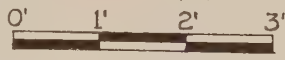
PLAN AND ELEVATION

C.D. COMMON DRAWER
C.L. " LOCKER
L. STUDENT "



STUDENT TABLE "B" DIETETICS LABORATORY

SCALE:



▲ AGNES FAY MORGAN ▲ ▲
▲ JOHN J. DONOVAN, ARCHT ▲
▲ COLLABORATORS ▲

FIG. 414.

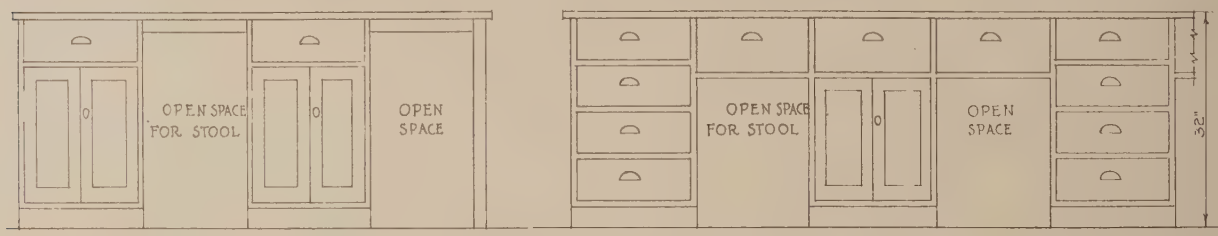
little paid help, for the food served. The working of this plan has nearly always been unfortunate, and illustrative only of a theoretically plausible but actually impractical scheme of education. Instruction and production cannot be yoked in this way, for instruction which is not immediately measurable in results that all may see, is almost certain to be neglected.

A legitimate use of the lunch room may be made, however, for training in management, planning, and buying, small classes of older students, already well grounded in the principles of cooking, menu making, and serving. Very little or none of the drudgery of the lunch preparation should be shifted on the shoulders of these students under the specious disguise of education.

be finished in a hard washable white or cream enamel or tiling, the floor should be of tiling or covered with linoleum.[1]

Effective relief of the hospitals from training of nurses in preliminary courses in choice, cooking, and serving of food cannot be brought about until the schools are able to duplicate such hospital devices as these in the training diet kitchen.

11. *Care of Equipment.* There is often expressed the view that one of the aims in the teaching of domestic science is training in habits of cleanliness in the conduct of the kitchen. This debatable view is expressed in one of the most inclusive and valuable of the treatises on home economics education.[2]



ELEVATIONS OF TWO TYPES OF DESK TABLES

Fig. 415.

Although the large quantity products of all the cooking classes should be marketed through the lunch room, there should be no contract to deliver every day a certain proportion of the food served. Large quantity cooking equipment need not be supplied in the cooking units, therefore, if the steam table, soup kettles, and other articles necessarily found in the cafeteria or lunch room kitchen can be used by the small class interested in that type of work.

Thorough familiarity with the labor-saving and large-quantity cooking utensils in use in commercial food establishments should form part of this trade training. Here again we note the necessity of professionalizing parts of the home economics curriculum which were formerly taught with the housewife's limitations constantly in view.

(*f*) Hospital Diet Kitchen Equipment. One of the vocational or prevocational courses now often emphasized in girls' high schools is that of food and nutrition or dietetics work for girls planning to enter nurses' training schools. For the optimum development of these important classes a small diet kitchen should be attached to the cooking laboratory. See Figure 401. This room should contain, in addition to the usual refrigerator, sink, cabinet, table and range, a small steam table, broiler, tray rack, dish sterilizer, and heated food truck. The walls should

The writer believes that in actual teaching far too much emphasis has been laid upon this aspect of the subject. Nothing is more natural or simple for the uncritical teacher than to make the *pièce de resistance* of every lesson the thorough cleaning of utensils, sinks, stoves, and tables. Often as much as twenty minutes out of the total of 60 or 80 or even 45 are devoted to this drudgery. Yet even more time than this must be given to repetition of these operations if automatic response in later practice is to be expected. In the meantime, since new mental concepts are not taught, the intelligent control of food choice and manipulation sought is entirely missed. An occasional lesson in kitchen housewifery should be introduced instead, and the work of scrubbing sinks and tables be left to the janitor.

The janitor or janitress in charge of home economics rooms should have sufficient help to be able to keep these rooms in spotless order, and should understand the special requirements of such care. In some small schools the teacher, with student help, may be obliged to supplement the janitor's efforts, but such work should be done out of school hours, and as a distinct part of the janitor's and not the class' duties.

The Serving Unit. In addition to the improvised serving equipment already mentioned as of value in supplementing the unit kitchen and unit kitchen desk,

[1] Ruth McNary Smith, *Equipping a Diet Kitchen*, Journal of Home Economics — Vol. 9, page 162 — 1917.

[2] Bulletin 36, U. S. Bureau of Education —*Education for the Home*, by Benjamin H. Andrews — 1914. Part I — page 28.

FIG. 416. — DOMESTIC SCIENCE ROOM, CLAWSON SCHOOL, OAKLAND, CALIFORNIA. *Mr. John J. Donovan, Architect.*

a more formal provision for meal serving in a dining-room should be made. The inclusion of some sort of dining-room in the home economics suite has of recent years become so general that only a few words need be said here as to details.

Size of Dining-room. The room to be used for dining-room need not be, for teaching purposes, larger than that required for the ordinary sized family, but should nevertheless be large enough to accommodate the occasional dinner or supper for school groups, such as faculty, school board, or students' society. Such a room might be 15′×18′ to 20′×24′ in size.

The intent in the latter provision is one of community usefulness which need have no bearing on the teaching carried on in the department. The caution mentioned before in the matter of the school lunch might be repeated here. Even though equipment be provided for the serving of meals to groups having definite connection with the school life, it should be understood that teachers and pupils in the food study department should be expected to assume responsibility for such service only when in the judgment of the director educational value may be derived from it.

In planning the space allowed for the dining-room, a third consideration besides the practice for the classes in serving and community usefulness is involved, that of alternative use of the room for other purposes. Frequently, no recitation room is provided for home economics classes, instruction being carried on in the cooking laboratory. For some lessons this arrangement is unsatisfactory and might economically be supplemented by use of the dining-room as a classroom. The extra equipment to provide for this double use of the room consists of a portable blackboard and a sufficient number of movable tablet armchairs. If a closet can be provided into which the usual round dining table can be rolled when not in use, still further usableness of the room is possible.

If the objection is raised that alternative use of this room for other than serving purposes is likely to detract from its homelike character, it may be pointed out in answer that only the skeleton of home conditions need be reproduced in the school, and that the exclusively domestic atmosphere often sought by domestic science teachers can be attained at too great cost, if efficiency in the use of expensive school space and equipment must be sacrificed.

The Floor and Wall Finish. The dining-room floor will naturally be finished in the same durable wood used

Mr. Edward Stotz, Architect.

FIG. 417. — DOMESTIC SCIENCE ROOM, SCHENLEY HIGH SCHOOL, PITTSBURGH, PENNSYLVANIA.

in other parts of the school, the finish being wax, oil, or varnish. Often a good quality of large rug is provided when the school can afford to use the room only as a dining-room. When it is used also for a recitation room the rug becomes a nuisance and may well be eliminated.

The walls should be finished in some attractive homelike style, the plaster tinted in soft shades, or a simple, plain wall paper used. The choice of color scheme of the room should be guided by exposure, amount of light, and view. Sunny rooms may be finished in grays, cool browns, blues and greens without seeming cold, while dark north rooms require yellows and warm reddish browns for successful treatment. It is usually best to select a neutral grayish or brownish tone for the walls and rug and to provide variety and accent in window hangings and pictures.

The whole problem of the selection of colors and furnishings for the dining-room, as well as for the housekeeping unit, constitutes a splendid exercise for the classes in house decoration. In order that the best use may be made of the opportunity by these classes, inexpensive and easily altered wall finish, curtains, and furniture should be chosen. In many large high schools the woodworking classes have been able to design and make part or all of the furniture, the sewing and art classes have designed and made curtains, wall stencils, table covers, and have repainted furniture and redyed fabric so as to set forth the dining-room frequently in new and charming guise.

In Figure 424 is shown a view of the practical and good-looking dining-room furnished in this way in the Lux School in San Francisco. This room is large enough to be used daily as dining-room for all the teachers of the school, but it is so designed and furnished as to serve excellently also for the class practice in the serving of home meals. The color scheme used in this case is golden brown.

Furniture. The necessary furniture for the dining-room consists of a round or square extension table, 6 to

20 dining chairs, and a serving table or buffet. In addition there may be a china cupboard, tea table, tea wagon, muffin stand. The latter articles are not indispensable, and most of them are best stored away in a roomy closet off the dining-room except when in use. The china cupboard may be dispensed with if a pantry between the kitchen and dining-room is provided. This latter plan, as shown in Figure 401, is on the whole most efficient for school purposes, since the removal and putting away of dishes may then be carried on without disturbing the group using the dining-room. Where space is limited, however, see Figure 403, either a movable or built-in cupboard may form part of the dining-room furniture.

The kind of furniture chosen should be governed by the taste and habits of the community as well as funds available. It is usually best to make a conservative choice, avoiding the passing fancy of the moment. The simple and graceful lines of some of the so-called colonial furniture will please long after the knobs and twists of certain other styles have become monotonous or tawdry. It need hardly be added that imitation woods or leather are entirely out of place in school furniture and that the best genuine materials finished to show what they are, which are purchasable with the money available, are most suitable under all circumstances. Plain oak furniture may be stained and waxed in a number of pleasing ways, all of them showing the grain of the wood, or may be painted and enameled to suit the surroundings and the needs of the classes. Birch, maple, even pine, cedar, or redwood furniture may be finished acceptably in either of these fashions, but should never be made to masquerade as mahogany or rosewood.

The provision of an open fireplace in the dining-room has been found in some places an admirable addition to the cozy and attractive appearance of the room. An example of this treatment somewhat too formally carried out is shown in Figure 426.

Serving Equipment. The quantity of china, silver, glassware, and linen required for a given school will depend largely upon their collateral use for other than teaching purposes. If the serving of lunch for teachers regularly, or the occasional dinner for large groups, is contemplated, tableware must be provided accordingly. For teaching purposes alone, service for six is ordinarily considered sufficient. This is true particularly when the individual serving outfit suggested previously is provided in connection with the cooking unit.

It is not necessary to list here the minimum of types of dishes, glassware, silver, and linen required for the equipment of the serving unit, since common sense and the experience of eating as well as serving meals will suffice to remind the reader of possible desirable additions. The quality in all cases should be of such character as to establish proper standards of taste in the minds of the students, but need by no means represent the outlay called for by expensive French china, Irish linen, and solid silver. Gay and beautiful patterns in semi-vitreous porcelain are obtainable, and are preferable to the monotonous and ugly durable dishes so often found in school dining-rooms. A bit less durability coupled with more endurability may well be found educationally efficient. A fair quality of linen of bold and handsome pattern might well be substituted for the severely plain covers so often used. In communities where the kitchen oilcloth and turkey-red cover are the rule in the homes,

FIG. 418. — ELECTRICAL EQUIPMENT USED IN THE UNIVERSITY OF NEW MEXICO.

Mr. Wm. B. Ittner, Architect.

FIG. 419. — COOKING-ROOM, GROVER CLEVELAND HIGH SCHOOL, ST. LOUIS, MISSOURI.

the cheapest sort of unbleached muslin attractively stenciled or stitched in the domestic art classes, plain white cotton damask, Japanese toweling, or other simple runner material might be used to indicate possible improvement without added expense.

When electric current is available at a reasonable price, one or two electric outlets in the floor or wall beside the dining table, and a representative article or two to illustrate the table use of electricity should be provided. An electrically heated coffee urn or percolator, toaster, or grill are appliances which are of considerable convenience and increasing availability.

Establishment of Standards of Taste. In choosing the table-service equipment the limitations of poverty and taste in the homes of the community should not be allowed to interfere too seriously with the introduction of the idea of higher standards of living among the students. In addition to poverty, lack of knowledge of, and desire for the more refined type of table service, as of other marks of good taste, sometimes may account for the existence of deplorable living conditions, particularly among immigrants. Discontent of the student with immediate home conditions may therefore be a lesser evil than the continuance of the ignorance which helped to produce such homes. Emphasis should, of course, be placed wherever possible upon the use of the least expensive means to bring about the desired result in comfort, harmony, and good taste, but the establishment of good standards of living in the real sense, apart from luxury or showiness, should never be sacrificed to unfortunate existing conditions.

Service with no Dining-room. If no space is available for a separate dining-room, provision should be made for practice in serving meals in the cooking unit. In the laboratory desk type of kitchen, space for this purpose may be difficult to obtain if the tables are arranged in parallel rows. In Figure 412 dining tables could be improvised in the four corners shown occupied by supply tables; in Figure 403, representing the horseshoe or hollow-square arrangement, the dining table might be placed within the square. With the unit kitchen type of arrangement, practice in service is much more easily arranged, since the space in the center of the open side of each unit may be utilized for this purpose. This is illustrated in Figures 401, 407, 423.

The Laundry Unit. Some provision should certainly be made for the teaching of the simple operations and the underlying principles of laundering in every scheme of home economics education. In this as in the other fields already discussed, both domestic and commercial types of equipment and performance need to be included. It is of interest to note that in England and Canada domestic-science educators have always placed a good deal of emphasis upon the science and art of laundering, nearly as much time being spent on this subject as upon food preparation. In the United States until very

recently but little thought has been given to the matter, although a few training schools have equipped elaborate laundries. It would seem wise and reasonable, however, to give to so necessary and so tedious a form of drudgery such dignity and assistance as a few lessons in the household science course will afford.

The amount of time spent in this way will be governed by the nature of the training sought, and by the character of the students instructed. In certain schools and localities only the simplest domestic type of laundry need be taught, while in others careful preparation of the girls for employment in commercial laundries is justified. The ever-growing tendency toward the specialization of this work and its performance outside the home must be considered by the domestic science teacher.

As was mentioned in the discussion of the cooking-unit equipment, separated and analyzed processes should be carried out in order that the student may acquire in-

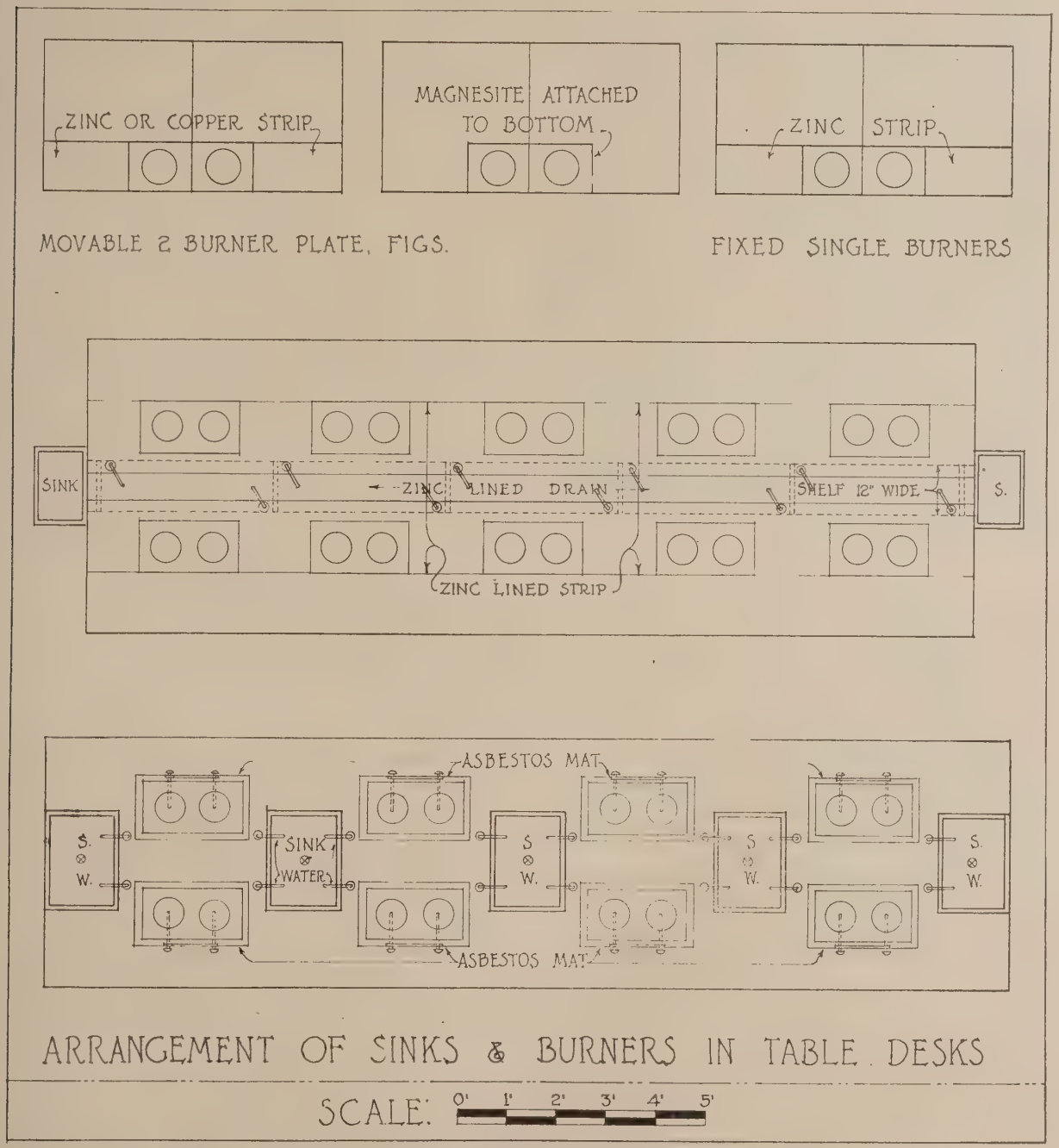


FIG. 420.

telligence in the control of the conditions of her work rather than merely rule-of-thumb skill by repetition of the task. In order to do this in the case of laundering instruction, the composition and physical properties of various types of water, soap, washing powders, starch and blueings, the structure of the textiles, and the reaction of common classes of dyes to different kinds of cleaning treatment, should be studied. The writer recalls asking the laundry instructor in a certain state university why pongee remains spotted when it has been

Fig. 421. — Type of Ready-made Movable Cabinet.

sprinkled before being ironed, and the answer, given with impressive authority, was that pongee silks must be ironed " bone-dry." Nothing further was forthcoming and no explanation was evidently felt to be necessary. Such a state of mind naturally results from the teaching of " complete and approved methods " of laundering, or cooking, or engineering, or any similar process.

The equipment for teaching laundry in a scientific way should include besides the tubs, wringers, washing machines and other appliances, full sets of chemical and other testing apparatus for the demonstration of the properties of the various cleansing materials and fabrics under consideration. This apparatus may, if necessary, be shelved and used in the foods laboratory which, if equipped with the chemical apparatus mentioned, will serve for much of the testing work done in the laundering lessons. Similarly certain parts of the apparatus provided in the sewing unit may be called into use for this purpose. The ironing-boards and irons, as well as the hand lens or microscopes used in the study of textiles, may serve in common the two uses.

In any case, separate space, however small, should be assigned for instruction in laundry problems if only to emphasize the need for eliminating laundry work from the home kitchen.

Size of Room. Smaller classes than those usually planned for the cookery courses must be organized for laundry instruction, usually not more than twelve to sixteen in a section. The room should therefore be large enough to accommodate four to six batteries of two tubs each, and the same number of ironing-boards and washing-machines, in addition to space for the built-in drier, the mangle, and stoves. A set of specially designed storage cupboards to hold the outfit needed by each student or group of students in carrying out laundering processes should be provided, along with small individual lockers to be assigned to the students for the personal belongings inevitably left over from lesson to lesson. One supply cupboard may be sufficient for small classes, but individual lockers are almost as much a necessity as they are in the sewing-room.

Floor space six by three feet in size should be allowed for each two students' washing apparatus, and three by four feet for each ironing-board. The drier may be built into a corner and occupy from 2 to 6 by 4 feet floor space. The mangle will vary in size, usually not exceeding 2 to 4 feet. Armchairs, or benches for class use, well illustrated in Figure 427, the teacher's desk, and two or three double burner gas stoves, or a small wood or coal laundry stove will take up the remainder of the space. The individual lockers may be built under the windows and need be only 12″ deep × 18″ wide × 30″ to 40″ high. This size admits hangers for waists and skirts without doubling them up.

In addition a laboratory desk of the type shown in Figure 420 with space for four to twelve students and equipped with sinks or trough, gas outlets, and hot and cold water supply is needed for the scientific testing work. In Figure 428, in a room 30′ × 26′ in size, is shown an advantageous and complete arrangement of a desirable equipment for the teaching of domestic and institutional or commercial laundry work. A smaller number of washing-machines, tubs, and ironing-boards may be used than that shown, but in order to make the subject worthy of school attention at all, the labor-saving devices and scientific testing must in some degree be included.

Walls and Floors. The walls must be constructed of waterproof and washable material similar to that mentioned in the discussion of the cooking unit. Tile or hard plaster are usually chosen. The floor should be provided with a drain and be made of composition or cement, covered with linoleum or rubber mats.

Good lighting and ventilation are particularly indispensable in the laundry room. A canopy similar

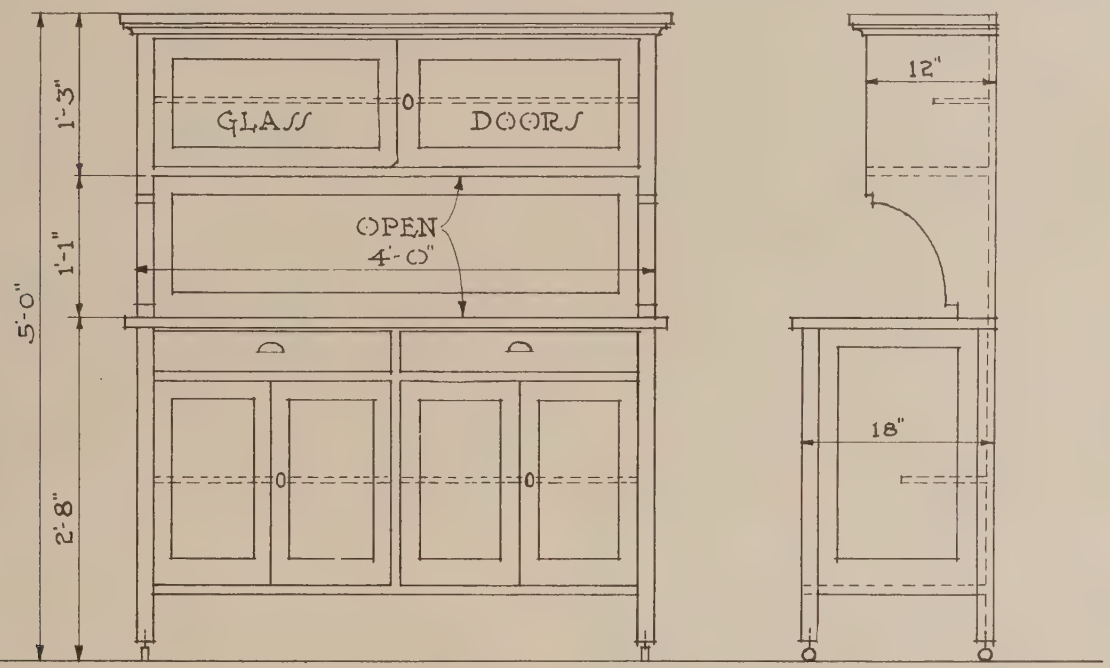
to that suggested for the cooking stove may be installed over the boilers or tubs, and a good flue should be connected with the drier. An excellent example of such ventilation is seen in the laundry laboratory at the Teachers College, Columbia University, Figure 429.

Equipment.[1] Stationary tubs or trays of porcelain or vitrified clay should be installed in groups of two with drains and hot and cold water outlets. If a single faucet is used the water may be carried into the adjacent washing machine more easily by means of a length of rubber hose. These tubs should be set at the right height for students of the size who are to use them, and may vary in height if classes of varying ages are expected. Portable tubs on benches may indeed be utilized in temporary or made-over quarters, but are not desirable for school use if stationary apparatus can be obtained.

A large variety of washing machines operated by hand, water power, or electricity are now offered in the market, and samples of such kinds as are available to the community should be included in the school equipment. So far as possible machines of various types, such as rotary, suction, corrugated, as well as those driven by different modes should be used. These machines may serve also as illustrative of the power machines in large laundries for vocational classes.

A good quality of ball-bearing wringer either attached to the machine or set up at each pair of tubs, a simple cold mangle, a gas heated or electrically operated mangle, are desirable additions to the laundry equipment.

In rural districts an outdoor clothesline or revolving drier may profitably be installed in a convenient court or yard, but for most schools the drier will have to be of the indoor type. Clotheshorses or wall driers may, of course, be utilized if necessary, but require more space than is ordinarily available. The built-in drier with flue heated by the school heating plant or by a small attached stove forms in most cases the efficient solution of this problem.



A MOVABLE KITCHEN CABINET

FIG. 422.

Wherever ironing-boards can be hinged to the walls and supported by a hinged leg when in use, they would best be installed that way, since the space can be utilized for other purposes when the boards are not in use. Heavy stationary iron standards such as are shown in Figure 430 are also acceptable. Separate sleeve boards should be provided in addition to the large board. Irons heated by the most convenient form of fuel in use in the community should be used. Electric irons, of course, are preferable for convenience and efficiency, since they furnish an even, easily regulated heat. Gas,

[1] For further details of equipment of the laundry laboratory, see *Laundering*, by L. R. Balderston, published by L. R. Balderston, 1224 Cherry Street, Philadelphia.

Mr. Wm. A. Poland, Architect.

Fig. 423. — Cooking-room, Junior High School, Trenton, New Jersey.

charcoal, or alcohol irons are sometimes advisable, and the ordinary stove-heated sadirons occasionally are the only kind available.

Clothes boilers, or a steam jet in the tubs, washboards of various types, sprinklers, starch kettles, clothes sticks, iron rests, iron holders, and clothes baskets are other necessary articles for the school laundry. All of these should be stored in properly designed cupboards when not in use.

The spaces for holding the various articles to be stored should be carefully proportioned to their uses and labeled. The largest spaces must be for the boiler and basket, within each of which certain smaller articles can be kept.

The Housekeeping and Home Nursing Unit. The problem of the provision in schools of the most efficient equipment for the teaching of all those arts and technique and principles involved in the care and furnishing of the house and in the home care of children and the sick has long been a difficult one to solve. It cannot be claimed that any universally satisfactory conclusion has so far been reached, nor is there any general agreement upon a working scheme for such instruction.

The most obvious answer to the question of equipment for this work is the practice apartment, or practice house. Many schools have installed such apartments with varying success. In certain districts where immigrants are numerous and the economic level is rather low these apartments or cottages have served as excellent social centers and Americanizing influences. Among the more prosperous and intelligent districts, however, they have been for the most part unused. In any case, such an apartment if built into the school in an isolated part of the building, accessible only to the students of the home economics courses and not occupied as an actual living place, is apt to take on an institutional and show character not compatible with the carrying out of the objects for which it was planned. Its furnishings are fixed and immovable and its use as a laboratory for house decoration is apt to be discouraged because of the expense involved in change.

A detached house near the school building presents some features which are advantageous but some which are distinctly objectionable. The isolation which makes it distinctive in character may prove a detriment by separating the work done there too completely from the rest of the school routine. Occasionally such a practice cottage may be used to advantage as living

quarters for one or more teachers or other persons connected with the school. In these cases rather more convincing working conditions may be attained, but it is obvious that as a continued plan the arrangement has its disadvantages.

Occasionally in high schools as in colleges or normal schools, groups of students are taken into the practice house to live for a given period and to discharge all the duties of the housekeeper under the supervision of a teacher. The writer questions the educational soundness of this plan, and certainly its difficulty of practical execution is plain. It would seem more rational than either of these schemes to provide for the housekeeping lessons a real laboratory in which separated and analyzed processes, rather than unthinking "skills," may be taught. The yearning for the exact atmosphere of the home which seems to dominate many home economics teachers may involve a greater sacrifice of efficiency than the momentary consistency will justify. Thus a laboratory for the housewifery course equipped with numerous samples of textiles, woods, cleaning mixtures, labor-saving devices, plumbing plans, and samples may offer a good deal more of lasting value to the student than a nicely furnished practice apartment with only one kind of floor, wall finish, plumbing, and other appurtenances.[1] The same criticism might apply to a suite of rooms to be used for house-furnishing classes. The writer believes that the latter course would best be given in a large well-lighted studio, filled with various property sets of doors, windows, floors, and with very little resemblance to a furnished home. A valuable feature of this type of work should be the excursions to furniture stores, museums, and private homes whenever possible. Indeed a very useful course might be given in this way without set school equipment.

The Community Room. In Figure 401 is shown a large living room with fireplaces, outside entrance, and connecting with a dining-room, which might serve as the studio for house-furnishing courses and the laboratory for the housewifery work. Its chief use, however, should be as a community social room, since it might serve as the center of the school life for students and teachers and parent teacher associations. For this reason it should be furnished with a goodly supply of simple comfortable chairs, with a rug or two, two or three tables, and possibly a piano. These articles are mentioned as valuable to the school rather than the home economics instruction, although they may be used occasionally in the latter. A convenient and charming social center for the school is shown in Figure 431 in the living-room of the Lux School in San Francisco.

The walls of such a room should be finished in some unobtrusive neutral tone, since they must act as a background for the hangings, rugs, papers, etc., to be displayed in the furnishing discussions. The floor should be finished, if possible, in oak or other hard wood, well waxed, since it is not unimaginable that it might sometimes be used for dancing. A number of exhibit cabinets with glass doors and fitted with narrow shelves should be built into the walls of the room. These cabinets offer a safe and usable storage space for the large variety

Mr. Wm. C. Hays, Architect.

FIG. 424. — TEACHERS' DINING-ROOM, LUX SCHOOL, SAN FRANCISCO, CALIFORNIA.

of sample collections which should form the background of the house management course.

Occasionally furniture and hardware dealers are willing to loan pieces of furniture or fixtures for class-work and then to exchange these from time to time. This sort of coöperation, of course, is invaluable. The house-furnishing studio or community room would naturally be used for the exhibition of these loans.

A few drawing boards or desks add considerably to the usefulness of such an exhibit room, and provision of steady light from more than one wall for the study of light effect on color is desirable. This room should consequently, if possible, be planned for a corner of the school building or of the home economics wing or building.

[1] For further details of equipment of housewifery laboratory, see *Housewifery*, by L. R. Balderston, Lippincott, 1918.

Mr. Wm. C. Hays, Architect.

FIG. 425. — TEACHERS' DINING-ROOM, LUX SCHOOL, SAN FRANCISCO, CALIFORNIA.

The Bedroom and Bathroom. A connecting suite of bedroom and bathroom are shown in Figure 401 as illustrating possible housing for the home nursing, personal hygiene, or care of children lessons, which are now frequently included in even the junior high school course. These rooms should correspond in finish to those in the homes of the students, but should be considerably larger than those found in the usual residence. The bedroom when not in use for instruction in bed-making or housecleaning could serve as rest room for the teachers, or for tired or indisposed girl students. This is the case in the bedroom shown in Figure 432. Such a room should be equipped with a double and single bed, dressing table, crib, tables, and chairs. The walls should be neutral in color, the windows easily shaded, and the floor covered by a simple comfortable rug. Plenty of closet space should be provided for the storage of extra bedding and the home nursing supplies. The latter might well be kept in narrow wall cabinets with glass doors. A first-aid outfit which may be drawn upon for the use of the whole school in emergencies may be kept in this room, and used for demonstration purposes.

Teaching Care of Children. Such equipment as is required for teaching the care of children should be stored and used in these rooms also. This should include a large doll with complete infant's clothing outfit, bathtub, brushes, crib, and feeding utensils.

The services of a real baby and its mother should be secured for at least some of these lessons, since the handling of a live infant in bathing, dressing, and feeding may involve difficulties not presented by the doll. Whenever possible a day nursery or hospital in the neighborhood should be called upon for assistance in providing practice in these matters.[1]

The bathroom shown in Figure 401 has been planned to offer all variety of equipment in the way of baths, such as sitz, foot, shower, which are used in professional nursing, as well as the usual home facilities, because of the possible pre-nursing instruction which may well be given in some schools to girls who plan on entering a hospital training school. In smaller schools less varied bath equipment is acceptable.

It will be noted that all of these rooms which serve the various purposes here outlined when taken together

[1] See further suggestions in Cooley, Winchell, Spohr and Marshall. *Teaching Home Economics* — Macmillan, 1918.

Mr. Edward Stotz, Architect.

FIG. 426. — DINING-ROOM, SCHENLEY HIGH SCHOOL, PITTSBURGH, PENNSYLVANIA.

form an apartment or complete living quarters. The reason is obvious, in that processes are to be explained and learned which are connected individually with all the types of rooms which a family needs for comfortable living. The provision of a suite of rooms to represent an apartment independently of such intensive use of each of these rooms as is here indicated seems to the writer indefensible.

The standard of furnishing and scale of living possible in the homes of the pupils must be kept in mind constantly in planning the details of this part of the department. It should be noted, however, that the object of all instruction should be analysis and understanding of processes and the acquiring of standards of taste, rather than immediate skill in accomplishment, and that therefore the slavish reproduction of the student's home conditions is neither necessary nor desirable. The case of vocational and trade training presents a slightly different problem, involving more immediate provision of manual technique.

The Clothing Unit. The development of the teaching of sewing, dressmaking, and millinery in the schools has been truly astonishing in recent years. Partly because of the rising prices of labor of all kinds a considerable impetus toward the home construction of at least simpler blouses, skirts, dresses, and hats seems to have occurred. To meet this tendency more and more classes in sewing have been organized for both schoolgirls and older women. For obvious reasons these courses are very often elected by girl students in preference to many of the more academic studies, whenever the choice is uninfluenced by such considerations as vocational or college preparatory necessities. How far the natural desire of the schoolgirl for the extra clothing made in this way should be allowed to interfere with the provision of less easily acquired mental training is a problem of considerable interest and difficulty of solution.

In spite of the larger numbers enrolled of late in sewing classes the tendency in both junior and senior high school clothing courses is and should be toward greater

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FIG. 427. — LAUNDRY ROOM, LUX SCHOOL, SAN FRANCISCO, CALIFORNIA. *Mr. Wm. C. Hays, Architect*

emphasis upon problems of purchasing, the economic condition of the garment-making trades, good taste in design and color, and away from the apportionment of much time for the acquisition of technique in hand and machine sewing, dressmaking, and drafting. Trade or vocational sewing classes in which power-machine work, machine hemstitching, and similar operations are taught constitute an important exception.

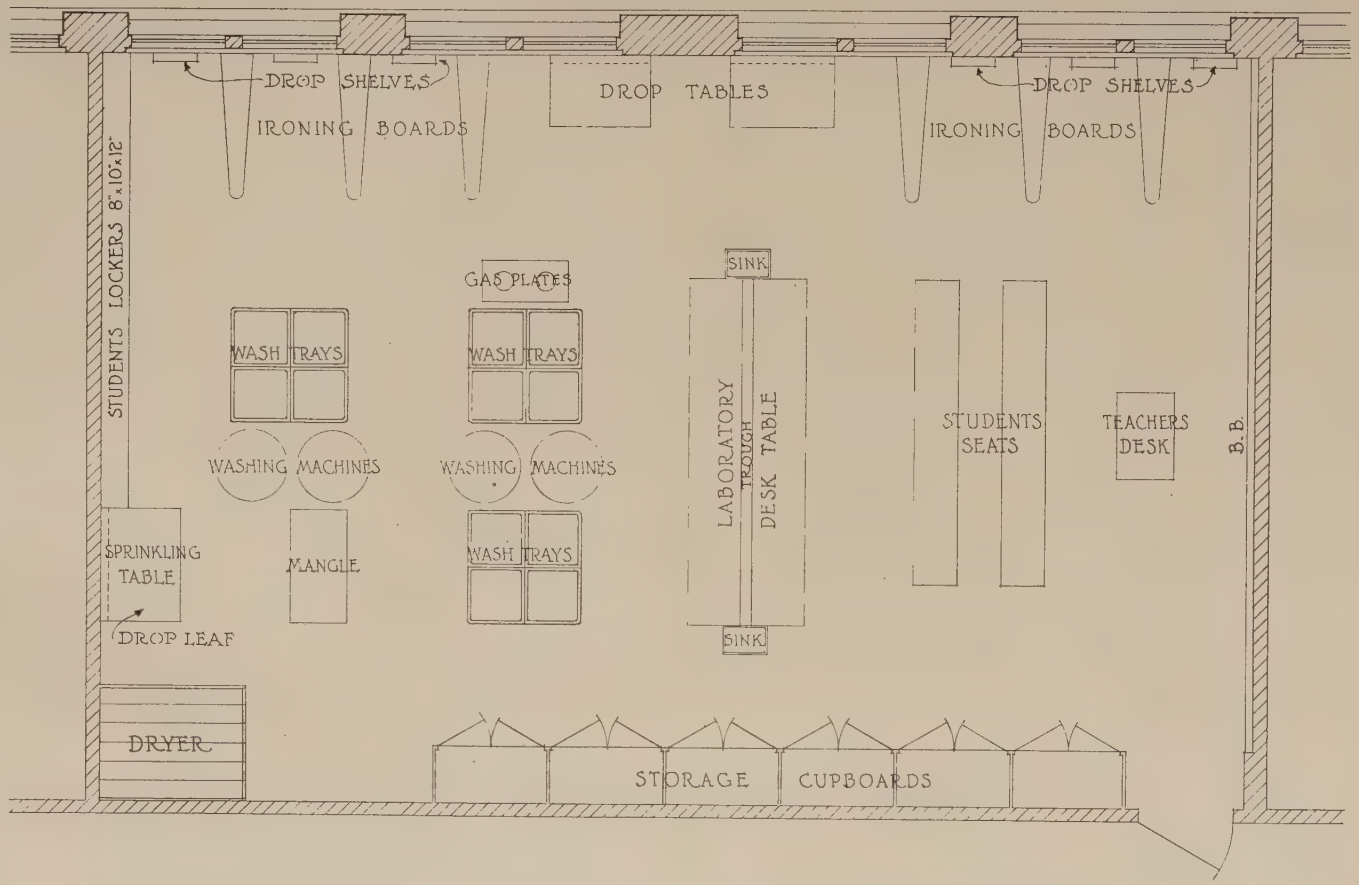
In the equipment of the clothing unit, therefore, provision should be made for textile testing and exhibits, sketching and draping on the one hand, and for power machines on the other. If vocational sewing courses are given they should be housed in a separate room from those occupied by the usual high school or grammar grade classes. The equipment to be provided for the latter may be divided into the following groups:

1. Textile testing and exhibits.
2. Drawing and modeling apparatus.
3. Sewing apparatus.

1. *Textile Apparatus.* Cabinets. Glass cabinets of the type mentioned in the description of the housekeeping unit are useful for the display of textile fibers, charts showing processes of manufacture, small models of weaving apparatus, and similar illustrative material. Storage space in cupboards with shallow deep drawers and adjustable shelves must also be provided for materials not at the moment on exhibition. A filing case for samples of cloth adds considerably to the efficiency of the textile work.

Laboratory Table. For the physical and chemical testing of fabrics which may well be introduced into the high school clothing course, a laboratory table of the kind described in the laundry unit discussion is of considerable value, provided no properly equipped laundry laboratory is at hand. It is unnecessary to duplicate this table in laundry and textile room, but it is usually wise not to rely for this purpose on the use of equipment in the cooking unit, since classes are often scheduled at the same time for cooking and sewing work. In small schools, however, the equipment in the cooking room if properly chosen should serve for the textile testing.

Provision for running water with sinks and gas outlets is necessary for this laboratory desk. Ordinarily one double table 10 feet long and 5 feet wide, accommodating 10 to 12 students at a time, is adequate. The table



A LAUNDRY LABORATORY

SCALE:

0' 5' 10' 15'

AGNES FAY MORGAN
JOHN J. DONOVAN, ARCHT
COLLABORATORS

FIG. 428.

should be inclosed below for storage of apparatus and chemicals in the usual laboratory fashion. It is entirely possible to equip the usual large cutting table in this way, with sinks let into the top under smooth board covers, and gas outlets below the top; see Figure 436.

Testing Apparatus. Powerful hand lenses, or low power microscopes, acid and alkali bottles, beakers, Bunsen burners, wire gauzes, tripods, clay triangles, are the chief pieces of apparatus needed for the qualitative tests possible for high school classes.

2. *Drawing and Modeling Apparatus.* The usual precautions observed in planning drawing rooms should be remembered in arranging the lighting of the clothing unit. North light is usually considered steadier and better for drawing, but sometimes this advantage is best sacrificed to the cheer of occasional sunlight, particularly in the case of grammar grade classes. In any case the light should fall over the left shoulder of the worker, and should be plentiful. Provision of adequate artificial lighting must also be carefully made, since afternoon and evening classes in these subjects are frequently organized.

Fig. 429. — Laundry Laboratory, Teachers College, Columbia University.

Drawing Apparatus. Drawing boards, either set in the usual adjustable fashion on pedestals, or supported on the sewing tables by adjustable blocks, should form part of the clothing unit equipment. These boards, and boxes of paints, pencils, rulers, etc., may be stored when not in use in a wall cabinet of the filing case type (see Figure 436) designed for this purpose. In Figure 434 is shown a class using such drawing boards in making preliminary sketches for a millinery lesson, and in Figure 435 for costume design work.

It need hardly be said that the clothing teacher should be thoroughly trained in art methods and technique before attempting such work as is implied here. In some cases the drawing and designing portion of the courses might best be given in coöperation with the art classes.

3. *Sewing Apparatus.* Walls and floor. The walls of the rooms used for the clothing classes may well be decorated attractively, since they are not apt to be exposed to fumes or steam. Calcimine in a subdued gray-brown, tan, gray-green, or similar tone, or a two-toned wall paper might be used, with wood trim in natural color and dull waxed finish. Washable glass-curtains of scrim or pongee if kept immaculate add greatly to the attractiveness of the windows.

The floor should be of oak or other hard wood, if possible, in order to avoid the oiled dirt-catching danger of the soft woods used in other parts of the building.

Cabinets. In no other schoolroom is there greater need for properly planned cupboard space than in the sewing-rooms. Individual lockers must be assigned students for work in course of construction, and these lockers must be of the right size and shape to receive the articles apt to be made. At least three kinds of locked cupboards should be available, (*a*) for dresses and coats, (*b*) for hats, (*c*) for flat work, underwear, etc.

(*a*) Cupboards to receive dresses and coats on hangers should be 24 inches deep and 64 inches high inside measurement, with a single rod running down the center two inches from the top upon which the hangers are hooked. The doors to these cupboards may be of wood or glass, and if smoothly sliding save floor space in opening. These cases may be used for exhibit purposes to advantage if glass doors are specified.

(*b*) Hat cupboards designed to hold four to six hats on raised forms, similar in construction to a hat trunk, are most economical of space. Usually four or five rows of these boxes built three or four deep are adequate, and provide a space each of about 20″×20″×20″ inside measurement.

(*c*) The drawers for flat work offer the best choice of space for individual lockers and students' equipment boxes. If these drawers are 26″×19″×6″ inside measurement, they are found to be satisfactory for a large number of articles. Enough locked drawers should be provided so that each student may have one for her exclusive use, and these drawers should be fitted into the spaces under the sewing table during the progress of the lesson. In Figure 433 the detail of an economical and complete combination of these cabinets is given.

Dress form closet. A closet for the dress forms must be provided, and this is perhaps best built into the walls of the fitting room. Such a closet needs to be 5 feet 6 inches in height and only 18 inches deep (5′ 6″×18″),

FIG. 430. — LAUNDRY LABORATORY, GROVER CLEVELAND HIGH SCHOOL, ST. LOUIS, MISSOURI.

Mr. Wm. B. Ittner, Architect

Mr. Wm. C. Hays, Architect.

FIG. 431. — HOUSEHOLD ARTS CLASSROOM, LUX SCHOOL, SAN FRANCISCO, CALIFORNIA.

if sufficient wall space is available to store the forms in a single row. This depth must be doubled or trebled if the forms must be stored in two or three rows. Sliding doors or a number of narrow hinged doors are necessary for these closets. A shelf cupboard of the same depth, but 3 feet high, built over the flat-work drawer cabinet serves to hold the waist forms.

Tables. Sewing-tables may be provided large enough to accommodate 1 to 6 students, but usually individual or double tables are chosen if space is available. Single tables should be $3' \times 5'$, and $2'$ $6''$ high, double tables $6' \times 5'$, or more economically made up of two single tables. If a drop leaf 2 feet long be hinged to the narrow end of the tables so arranged that when the leaf is raised a single long table is constructed from each row, the best possible cutting table will be provided. (See Figure 436.) The sewing-tables are easily constructed of sugar pine, maple, birch or other semi-hard wood and should be finished with a stain to match the wood trim or the walls of the room. Spaces for the insertion of the locked individual drawers described above should be provided below the top of these tables and opposite each student's place. During the lesson the drawer may be kept conveniently in these spaces, and stored in the wall cabinet at other times.

Drafting and cutting tables $7' \times 3' \times 2'$ $8''$ high are sometimes provided, particularly in trade-sewing rooms, but for most schools are no longer considered indispensable. If such a table is provided, it should be equipped with sinks and gas piping for use in textile testing, as previously described.

Mirrors. Flat wall mirrors, triple full length movable mirrors, $4'$ long, are usually used in the fitting-room or in a screened corner of the sewing-room. Hand mirrors and small triple mirrors should be provided in addition.

Machines. Both single and double thread sewing machines and at least one with electric motor should be available. Electric wall plugs should be convenient to all machines. Five or six machines are usually sufficient for any ordinary-sized sewing class, that is, one machine to three or four students.

Chairs. Bent-wood chairs with cane seats are the favorite choice for the sewing-room because of their lightness and durability. Any light wooden chairs, stained to match the tables, may be used.

One or two ironing-boards, hinged to the wall inside

FIG. 432. — TEACHERS' REST ROOM, LUX SCHOOL, SAN FRANCISCO, CALIFORNIA. *Mr. Wm. C. Hays, Architect.*

a shallow cupboard or supported on a stout collapsible frame and adjacent to electric outlets equipped with a red incandescent light as current indicator, must be specified. Electric irons of varying weights may be stored when not in use in these same shallow cupboards. A two-burner gas plate and sink near the ironing-board are convenient for many fitting, cleaning, dyeing, and pressing purposes.

A generous-sized blackboard, bulletin board, pinking machine, burlap demonstration frame, teacher's desk, bookshelf or bookcase, paper roller, and a folding screen or two complete the list of the larger appliances necessary in the sewing-room. Such small articles as tape measures, yardsticks, skirt rules, thimbles, tracing wheels, wire cutters, etc., either are assigned to students to be kept in individual lockers or are stored when not in use in drawers under the sewing-table tops or in wall cupboards.

The fitting-room. If a separate fitting-room can be provided, considerable extra convenience and value will be attained. Sometimes a fitting-room may be economically planned to occupy the space between two sewing-rooms. If no fitting-room is allowed, a corner of the sewing-room must be screened off for this purpose. One or two fitting pedestals, a screen, a triple wall or movable mirror, a flat wall mirror, one or two chairs or benches are all the furnishing necessary. In Figures 403, 433, 436 the details of convenient fitting-rooms are shown. The dress-form closet is often conveniently built into the walls of this room.[1]

Trade-Sewing Equipment. If vocational or Smith-Hughes trade-sewing classes are organized in the school, a separate classroom should be planned for them, if possible. Since this work is treated in detail in the chapter on Vocational Education (Chapter VIII), but few comments need to be made upon it here.

The trade-sewing room should be equipped with a shaft supplying power to four or five sewing machines,

[1] For further details of the Equipment and Use of the Clothing Unit, see Domestic Art in *Woman's Education*, by Anna M. Cooley, Scribner, 1911.

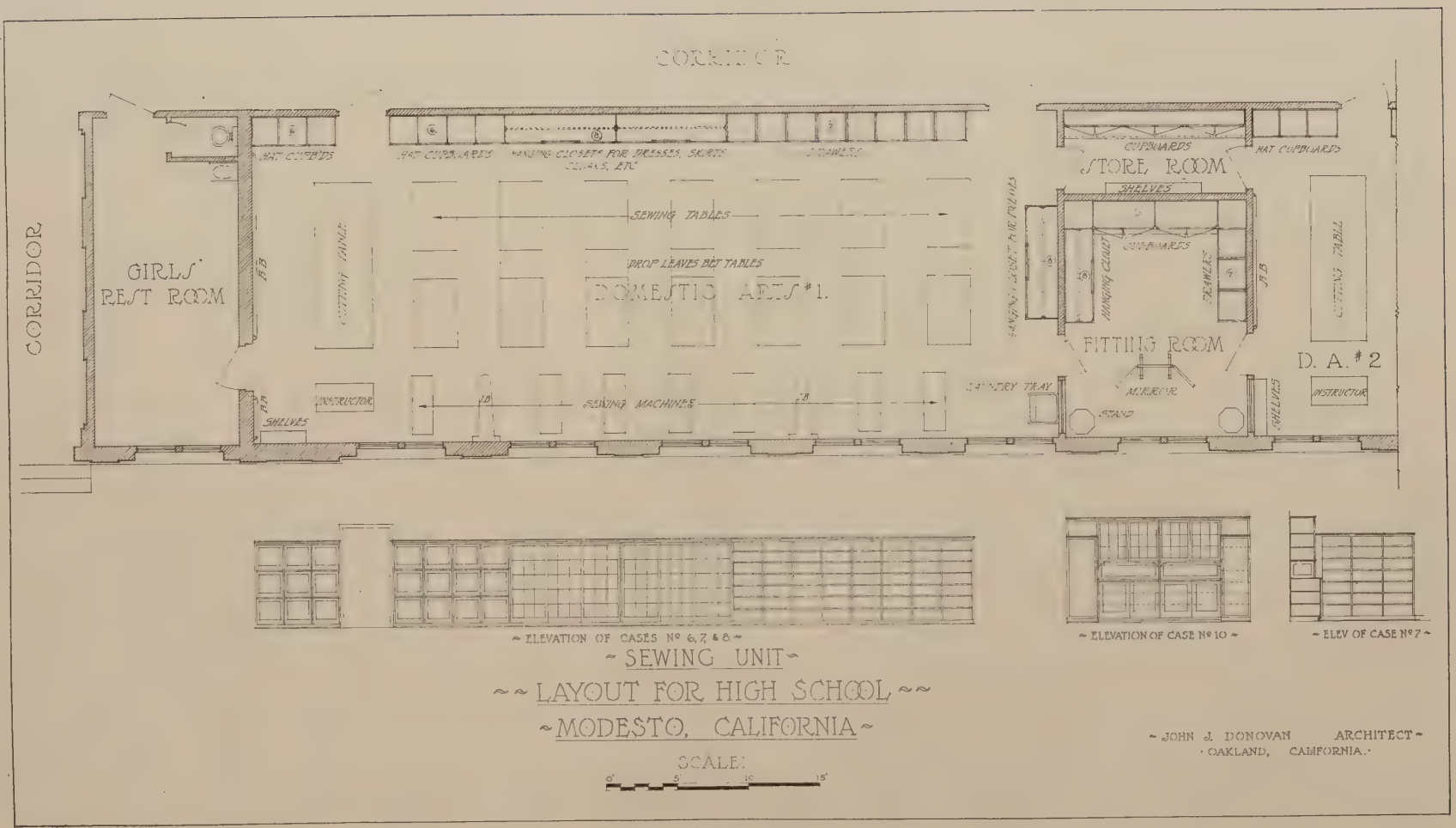

CORRIDOR
CORRIDOR
GIRLS' REST ROOM
HAT CUPB'DS
HAT CUPBOARDS
HANGING CLOSETS FOR DRESSES, SKIRTS CLOAKS, ETC
SHAWLS
SEWING TABLES
DROP LEAVES BET TABLES
DOMESTIC ARTS #1.
CUTTING TABLE
INSTRUCTOR
SEWING MACHINES
SHELVES
CUPBOARDS
HAT CUPBOARDS
STORE ROOM
SHELVES
HANGING CLOSET FOR FURS
HANGING CLOAK
CUPBOARDS
DRAWERS
FITTING ROOM
HISTORY TRAY
MIRROR
STAND
SHELVES
D. A. #2
CUTTING TABLE
INSTRUCTOR
~ ELEVATION OF CASES Nº 6, 7 & 8 ~
~ ELEVATION OF CASE Nº 10 ~
~ ELEV OF CASE Nº 7 ~
~ SEWING UNIT ~
~~ LAYOUT FOR HIGH SCHOOL ~~
~ MODESTO, CALIFORNIA ~
SCALE:
0' 5' 10' 15'
~ JOHN J. DONOVAN ARCHITECT ~
· OAKLAND, CALIFORNIA. ·

FIG. 433.

Mr. Wm. C. Hays, Architect.

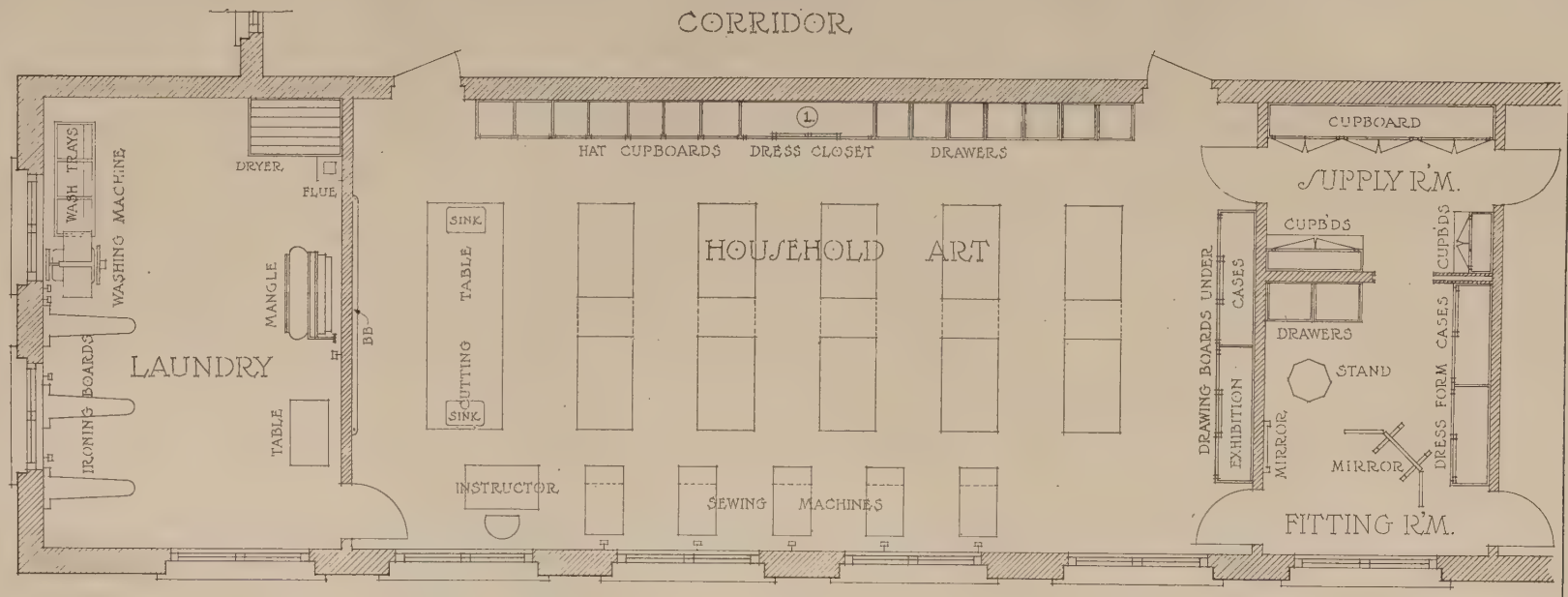
FIG. 434. — HOUSEHOLD ARTS DRAWING ROOM, LUX SCHOOL, SAN FRANCISCO, CALIFORNIA.

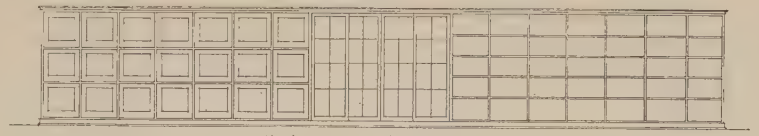
with individual wall or floor electric outlets for the power machines, hemstitching, and finishing machines. Large cutting tables, comfortable chairs, and carefully adjusted lighting fixtures are also necessary parts of this equipment. It is desirable here to duplicate the garment-making trade conditions, so far as can be done without sacrifice of comfort and efficiency in teaching. Figure 437 shows an excellent type of sewing-room adapted to school conditions, yet providing all the appliances for trade training.

It is understood, of course, that all the equipment previously described as indispensable for general sewing and clothing construction teaching should be accessible to the trade classes, since the manipulation of the power machines must be considered merely one important detail in the trade-sewing instruction.

Mr. John J. Donovan, Architect.

FIG. 435. — COSTUME DESIGNING CLASSROOM, OAKLAND TECHNICAL HIGH SCHOOL, OAKLAND, CALIFORNIA.





~ ELEVATION OF CASE Nº 1. ~

~~~ HOUSEHOLD ART SUITE ~~~
~~ FOR A JUNIOR HIGH SCHOOL ~~

SCALE:

0' 5' 10' 15'

▲ AGNES FAY MORGAN ▲
▲ JOHN J. DONOVAN ARCHT ▲
▲ COLLABORATORS ▲

FIG. 436.

FIG. 437. — TRADE SEWING-ROOM, LINCOLN HIGH SCHOOL, LOS ANGELES, CALIFORNIA.

CHAPTER XXIV

THE CAFETERIA

By William R. Adams, *Engineer of Hotel Equipment Department, Mangrum Otter Company, Inc., San Francisco, California*

I. The Kitchen. (1) The Bake Oven. (2) The Range. (3) The Cook's Table. (4) The Saucepan Rack. (5) The Cook's Sink. (6) The Meat-cutting Block. (7) The Power Food Chopper. (8) The Mixing Machine. (9) The Power Vegetable-peeling Machine. (10) The Vegetable Preparation Table. (11) The Dish-washing Machine. (12) The Dish Tables. (13) The Pot Sink. (14) The Tray and Glass-washing Sink. II. The Storeroom. III. The Cold-storage Room. IV. The Dining-room. (1) The Serving Counter. (2) The Steam Table. (3) The Hot-water Pan. (4) The Dish-warming Compartment. (5) The Cold-drink Section. (6) The Urn. (7) The Tray Slide. (8) The Checking Table. (9) The Drinking-fountain.

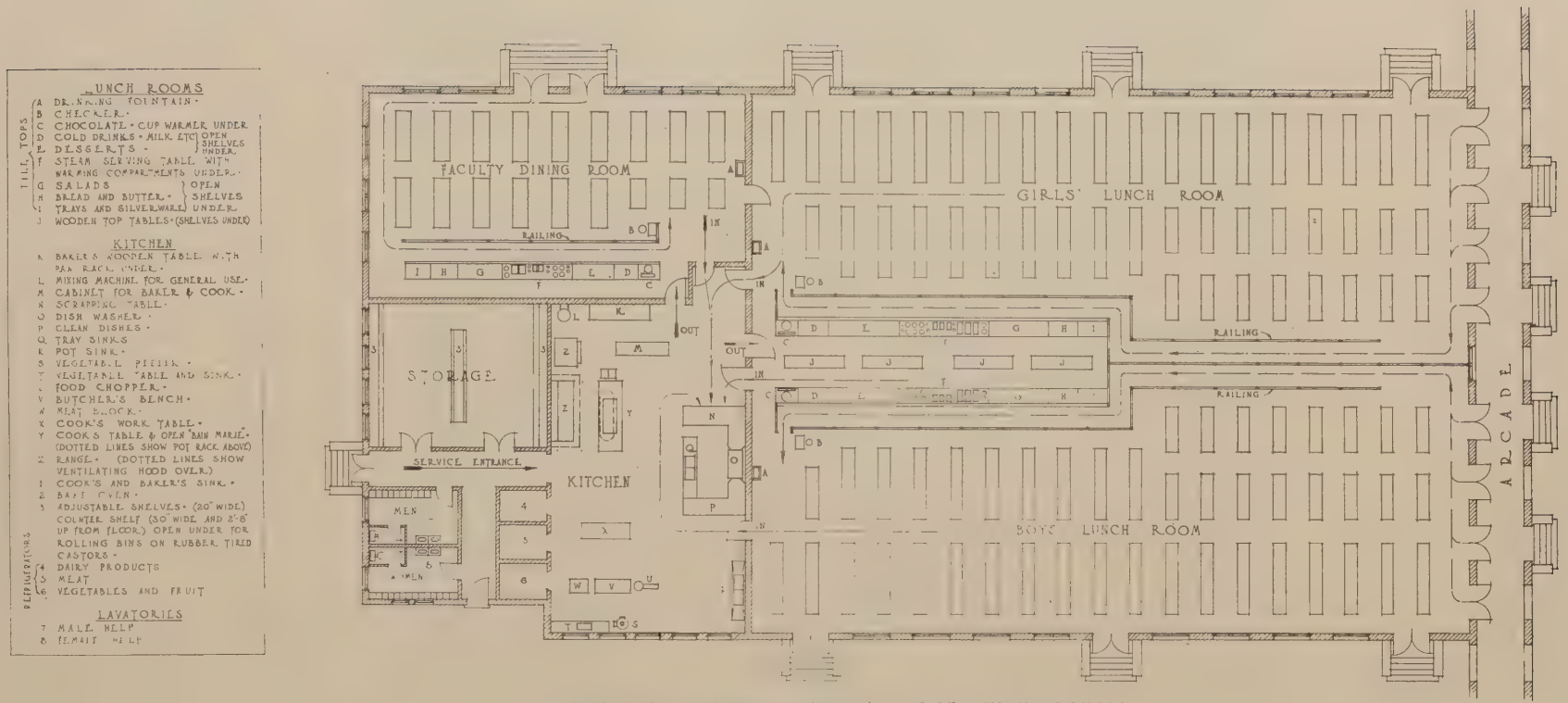
There is no longer any question of the necessity of having a lunch room in an up-to-date high school. This is especially true for large city high schools and for union district schools to which the students come from long distances. Nor is the lunch room merely a place where cold food brought from home may be eaten. It is a department of the school organized for the purpose of maintaining the health of the pupils through their eating, very much as the physical education department cares for their health through exercise. It must be a place where the student can obtain warm, wholesome food, served in an appetizing manner and at a reasonable price. Its construction must provide for pleasant surroundings and proper ventilation. The best arrangement to meet all these conditions is the cafeteria, or, as it might be termed, the self-serving lunch room.

In order to provide good food at a price as near as possible the actual cost, it is necessary to cut down to a minimum the amount of paid help. It is possible to do this under the cafeteria system because, in the first place, each individual serves himself, and secondly, student helpers can be employed in assisting behind the serving counter and in returning soiled dishes to the dish-washer. The work of the student helpers will cost only the price of their meals. Thus the paid help for a school of about eighteen hundred students can be reduced to about five in the kitchen and four in the dining-room. Those in the kitchen should consist of the cook and his assistant, the baker, the dish-washer, and the general utility man. The four in the dining-room should be occupied mostly with the serving counter.

In the designing of the cafeteria and in the manufacture and installation of its various fixtures, there are many things that must be constantly in mind, the combination of which, if properly designed, will mean a perfect working system. First, and above all, proper sanitation must be obtained both in fixtures themselves and in the general arrangement of the fixtures. There must be ample space around each one of them to allow for thorough cleaning of the floor and wall. The sinks and other equipment that are set against the walls should be so placed that there can be no pockets for the accumulation of dirt. Second, the whole arrangement must be pleasing to the eye. Third, the plant must be efficient; there must be no loss of labor, food, or fuel.

The dining-room should be large enough to accommodate the maximum number of persons to be served, that is, from one-third to one-half of the school enrollment. In form (see Figures 438, 439, 440, and 441) it should be either rectangular or square. If the maximum number of persons to be served at one sitting is six hundred, the room should have the dimensions of $90' \times 100'$, including the space required for the traffic aisles and the serving counter. Access to the serving counters should be had by means of traffic aisles, leading directly from the entrance door, past the food, to the checker's station. These traffic aisles should be $4'$ in width, and should, of course, be railed off from the dining-room proper.

The Kitchen. — The kitchen, if it is to be really serviceable, will be found in a position adjoining the dining-room, somewhere to the rear of the serving counters, and located centrally if possible. Passage between the dining-room and the kitchen can be provided by means of large double swinging doors of size $3'\ 6''$. These will permit the moving of trucks in and out without any danger of jamming. The kitchen should be large enough to accommodate without congestion


LUNCH ROOMS
A DRINKING FOUNTAIN.
B CHECKER.
C CHOCOLATE - CUP WARMER UNDER
D COLD DRINKS - MILK ETC } OPEN SHELVES UNDER.
E DESSERTS -
F STEAM SERVING TABLE WITH WARMING COMPARTMENTS UNDER.
G SALADS } OPEN
H BREAD AND BUTTER - } SHELVES
I TRAYS AND SILVERWARE } UNDER.
J WOODEN TOP TABLES - (SHELVES UNDER)
TILE TOPS
KITCHEN
K BAKER'S WOODEN TABLE WITH PAN RACK UNDER.
L MIXING MACHINE FOR GENERAL USE.
M CABINET FOR BAKER & COOK.
N SCRAPPING TABLE.
O DISH WASHER.
P CLEAN DISHES.
Q TRAY SINKS
R POT SINK.
S VEGETABLE PEELER.
T VEGETABLE TABLE AND SINK.
U FOOD CHOPPER.
V BUTCHER'S BENCH.
W MEAT BLOCK.
X COOK'S WORK TABLE.
Y COOK'S TABLE & OPEN BAIN MARIE. (DOTTED LINES SHOW POT RACK ABOVE)
Z RANGE. (DOTTED LINES SHOW VENTILATING HOOD OVER.)
1 COOK'S AND BAKER'S SINK.
2 BAKE OVEN.
3 ADJUSTABLE SHELVES - (20" WIDE) COUNTER SHELF (30" WIDE AND 2'-6" UP FROM FLOOR.) OPEN UNDER FOR ROLLING BINS ON RUBBER TIRED CASTORS.
4 DAIRY PRODUCTS
5 MEAT
6 VEGETABLES AND FRUIT
REFRIGERATORS
LAVATORIES
7 MALE HELP
8 FEMALE HELP
FACULTY DINING ROOM
GIRLS' LUNCH ROOM
BOYS' LUNCH ROOM
RAILING
STORAGE
SERVICE ENTRANCE
KITCHEN
MEN
WOMEN
OUT
IN
ARCADE

PLAN OF CAFETERIA FOR A LARGE HIGH SCHOOL

Fig. 438.

all the fixtures necessary in carrying on the work. On the other hand, it should not be so large that it will require any unnecessary labor in the preparation of the food. Proper lighting must be secured either by well-placed windows or by skylights. All windows and doors opening into the kitchen should be of the self-closing type, and they should be thoroughly protected against flies and dust. When fly screens are used, the screen should consist of about 196 squares to a square inch. Thorough ventilation must be provided, by mechanical means when the ordinary natural method is not satisfactory.

It is good practice to keep all the kitchen work, including vegetable preparation and dish-washing, in one room, thereby doing away with all partitions, eliminating ugly corners and dirt pockets, and keeping the whole system under the eye of the chef, who should be in full charge of the kitchen work, and responsible for its neatness.

The kitchen equipment should include the following: bake oven, range, ventilating canopy, cook's table, pot rack, cook's sink, cutting block, power food chopper, power vegetable peeler, power mixing machine, vegetable preparation table and sink, dish-washing machine with scrapping and clean-dish tables, pot sink, tray, and glass-washing sink.

The Bake Oven. — The bake oven should be of the portable type and capable of turning out about 100 1-pound loaves of bread per baking. This type of oven can be obtained to burn gas, wood, or coal.

The Range. — The range should be about 10′ long and of a type best adapted to burn the cheapest and easiest obtainable fuel. Gas is the most commonly used fuel, but there are localities where coal, wood, or fuel oil is used exclusively. The range should have three ovens, each capable of accommodating two 22″ × 22″ roast pans, one on bottom and one on shelf. If there is no hot-water system provided, hot water may be obtained by fitting the range with a water back and connecting the latter to a hot-water storage tank. This means of heating should not, however, be resorted to unless it is absolutely necessary, as it has not been found entirely satisfactory.

The canopy over the range should be made of iron, galvanized iron preferred, and should extend at least 1′ beyond the front and ends of range. It should be about 30″ high, with the lower edge of the front and ends 6′ 4″ in clear from the floor. A ventilating stack made of galvanized iron should extend from the center of the top of the canopy to a proper height above the roof of the building, and there be fitted with a cap. This stack should be about 16″ diameter. If mechanical means of

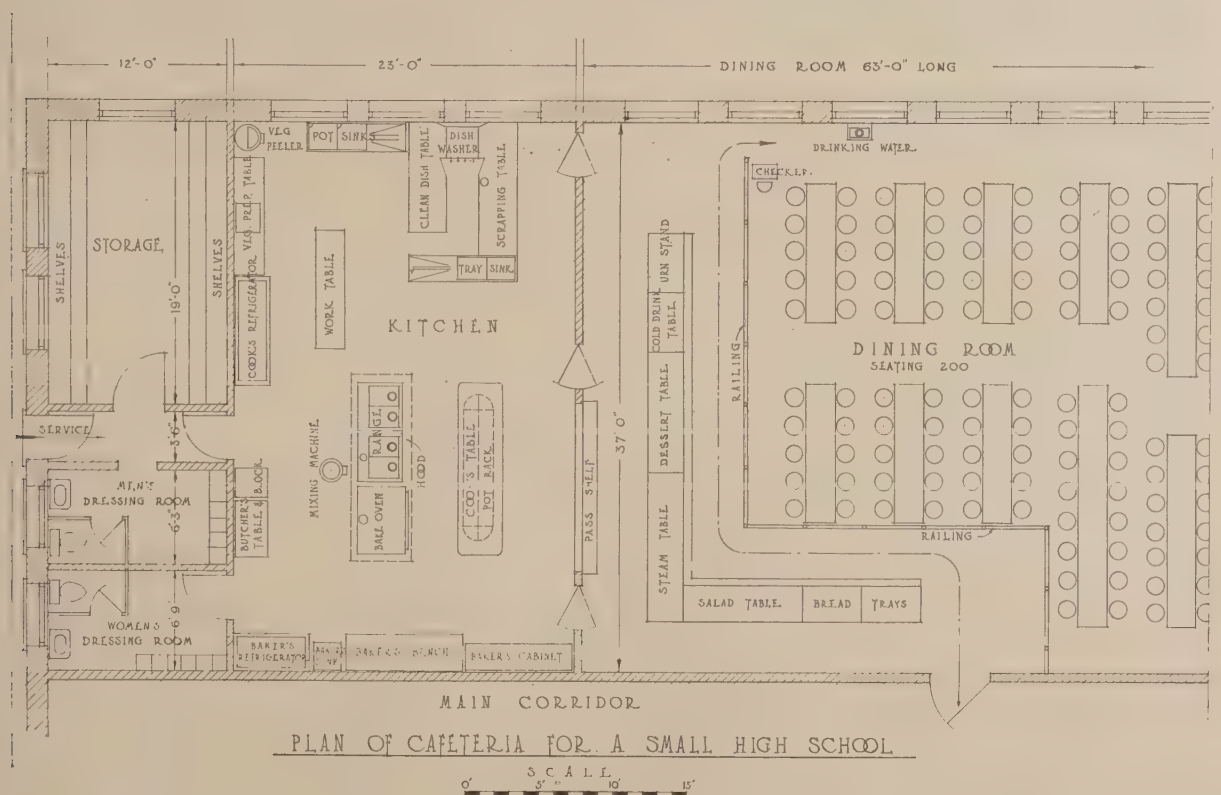


FIG. 439.

FIG. 440. — GROVER CLEVELAND HIGH SCHOOL, ST. LOUIS, MISSOURI. *Mr. Wm. B. Ittner, Architect.*

ventilation are used, a pipe 12″ in diameter will be sufficient. Whenever the pipe runs near woodwork, precaution should be taken to insure against fire, as the accumulation of grease in such pipes is very inflammable and might cause serious results should it become ignited.

The Cook's Table. — The cook's table is placed about 4′ in front of the range. It should be about 12′×4′×34″, with the top made of the best grade of selected ash, set together and held tight with glued-in wooden dowels. A "bain marie" about 4′×20″×9″, set into the top, is a very handy arrangement for keeping the food at the proper temperature, until it is carried to the serving table in the dining-room. This pan should be made of either heavy cold rolled copper or of No. 16 galvanized iron. It should have a perforated false bottom, made of the same material and set 1″ clear of the bottom so that the food utensils will have a free circulation of hot water all around. The water should be kept at a proper temperature, using either steam heating coils, set into the pan, or gas burners of proper size placed under the pan. There should be a $\frac{1}{2}$″ hot-water inlet for filling, and $1\frac{1}{2}$″ standing waste outlet for draining.

The cook's side of table should be provided with drawers for the cook's tools, etc. A galvanized iron latticed shelf, placed under the table and 10″ clear of floor, is convenient for the accommodation of reserve pots and pans.

The Saucepan Rack. — The saucepan rack of dimensions 8′ 0″×2′ 0″ should be constructed of $\frac{5}{16}$″×$1\frac{1}{2}$″ iron bars and suspended from the ceiling about 5′ 0″ above the cook's table. The best style of rack is the triple bar type, with the center bar inclined; the higher end being level with the side members, and the lower end about 1′ 0″ below. The pan hooks are riveted on, about 1′ 0″ apart. The hangers should be well cross-braced to prevent swaying.

The Cook's Sink. — The cook's sink must be placed in a location convenient for the cook's use, preferably at one end of the cook's table. The sink should be made of galvanized iron not lighter than No. 14 gauge; its dimensions are about 30″×24″×33″ with a depth of 16″. All joints should be well riveted, soldered, and scraped smooth. The top edges of the sink should have a half oval galvanized iron band or a wrought iron riveted and soldered thereto; the inside must be provided with

Messrs. Perkins, Fellows & Hamilton, Architects.

FIG. 441. — NEW TRIER TOWNSHIP HIGH SCHOOL, KENILWORTH, ILLINOIS.

a standing overflow waste outlet, protected by a removable corner strainer made of the same material as the sink; this strainer prevents the food scraps from entering and clogging the sewer. The sink should have four galvanized wrought-iron legs riveted to each corner and extending to floor.

The Meat-cutting Block. — The meat-cutting block should be located near the meat compartment of the refrigerator, so that meat can be cut to suit needs and returned without permitting it to become warm. This block is made in standard sizes, but 30″×30″×17″ is about the right size. It consists of a series of maple strips placed vertically, well glued and held together by iron rods running through and drawn up tight with nuts. The block is supported by four turned legs.

The Power Food Chopper. — The power food chopper (Figure 442) is placed near the meat block. This machine is a very convenient article of equipment and relieves the cook of the labor of chopping all meats and vegetables; in fact he is able to go on with his other work while the chopping is being done.

The Mixing Machine. — The mixing machine (Figure 443) might be termed a machine for all work, and, because of its general use, it should be placed at a point easily accessible from all parts of the kitchen. It is used for the mixing of pastry, mashing of potatoes and other vegetables, straining of soups, and for many other things. An attachment is furnished for each different operation, together with two one-piece, tinned mixing bowls of about 30 and 80 quart capacity respectively.

The Power Vegetable-peeling Machine. — The power vegetable-peeling machine (Figure 444) should have a capacity of about 30 pounds of potatoes at one charge; this machine should be set near the vegetable compartment of the refrigerator and also near the vegetable table and sink. As water is constantly sprayed over the vegetables while they are being peeled, care must be taken to protect the electric motor. The machine must be equipped with a special guard for this purpose, or the motor must be set above and out of reach of water. This machine is provided with a waste outlet, but it is a better practice to have the discharge go into an open hopper rather than directly into the sewer. This arrangement eliminates the chance of sewer gas entering and mixing with the vegetables.

The Vegetable Preparation Table. — The vegetable preparation table should be placed adjacent to the peeling machine and should be about 8′ 0″×2′ 0″.

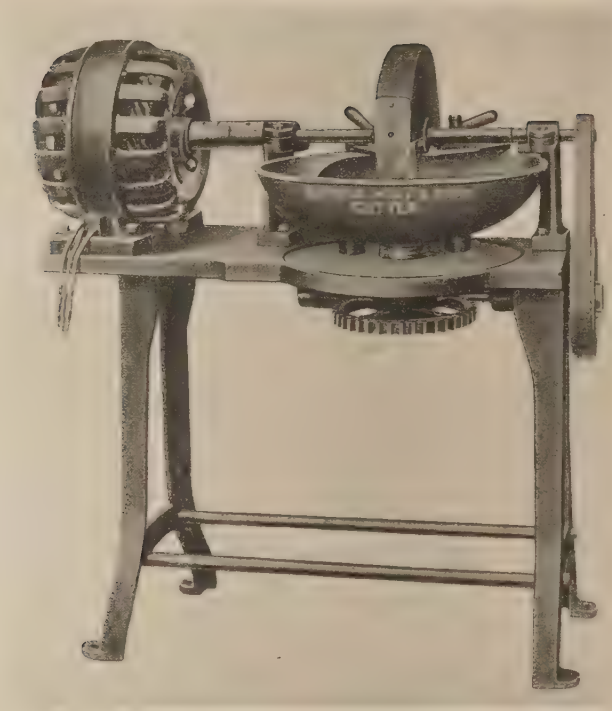


FIG. 442. — POWER FOOD CHOPPER.

Heavy galvanized iron with edges turned down all around makes a very satisfactory and sanitary top. The legs can be made of either galvanized wrought iron or galvanized pipe with flange at the bottom as desired. A removable ash cutting board should be provided for the cutting of vegetables and a sink with dimensions of about 24″×21″×10″ should be set flush with table top. Both sink and top should be of the same material.

The Dish-washing Machine. — The washing and sterilizing of dishes and glasses is one feature of the whole system that should be given a great deal of consideration because of the danger of the spreading of disease if this work is not properly done. In fact, in many localities there are laws which require that the dishes and glasses used in restaurants and cafeterias be properly sterilized. The dish-washing machine (Figures 445 and 446) with the accompanying tubs should be set as near as possible to the exit door from the dining-room into the kitchen, so that soiled dishes can be immediately unloaded without having to cross the kitchen. This arrangement also leaves the clean dishes in a handy location for easy delivery to the serving tables.

There are a number of dish-washing machines which are found to be very satisfactory, the inclosed stationary-dish type having perhaps more advantages than the open submerging type, as the breakage of dishes in the former is reduced to a very small percentage. This absence of breakage is due to the fact that the dishes are placed in wooden racks which hold them away from each other, the water being forced over them through washing jets. The water is supplied by means of a powerful electrically driven pump which is part of the machine. The rinsing is accomplished by use of spraying jets placed in such position that fresh water, direct from the boiler, is sprayed on the dishes from all points.

The Dish Tables. — The soiled- and clean-dish tables (Figure 447) should be set up and connected to the dish-washing machine, one on each end; the connection must be made watertight so that no leakage will occur at the junction. The clean-dish table should be so set that it will drain back into the machine. The soiled-dish table drain to a 2″ waste outlet at some convenient point in order to allow the liquids from the dishes to separate from the solid matter. A 6″ rubber top scrapping ring plug should be fitted into a hole at proper location in this table to take care of solid matter. This ring plug should extend above the table top to prevent the silver from falling through into the garbage receptacle below. These tables should both be supported by 1″ galvanized pipe legs with floor flanges.

The Pot Sink. — The pot sink should be made of No. 12 or No. 14 galvanized iron, having one washing and

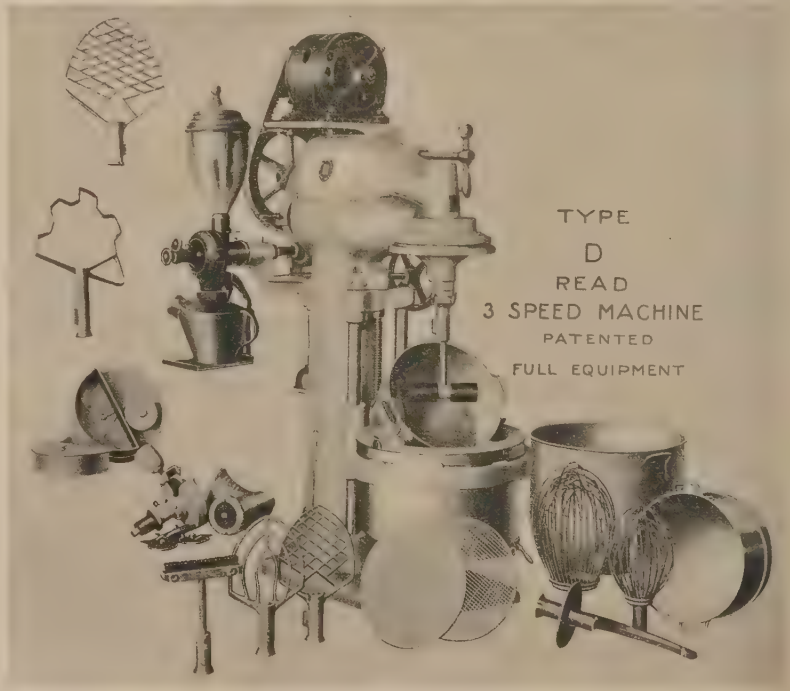


FIG. 443. — MIXING MACHINE.

one rinsing compartment, each 30″×24″×16″, fitted with a 2″ standing overflow waste outlet. Each waste outlet should be protected by a sliding removable corner strainer made of same material as the sink; this protects the waste lines from being clogged when the standing overflow plug is removed. A removable sliding pot rack should be furnished with the sink so that pots can be handled above the water line for the purpose of scraping.

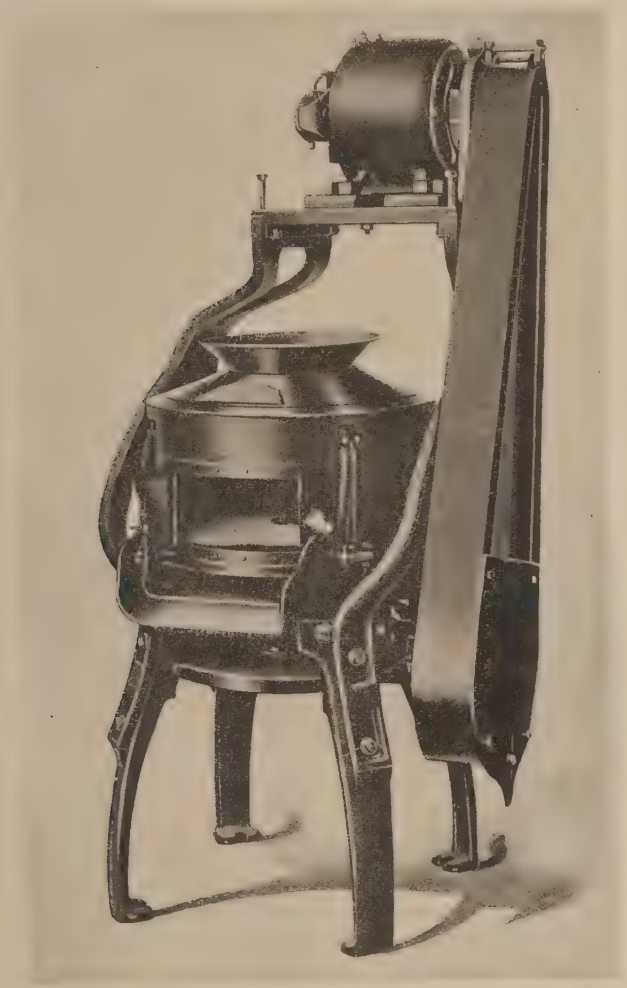


Fig. 444. — Vegetable-peeling Machine.

Two drain tables, one on each end and about 24″ long and the width of the sink, should be rigidly connected thereto. The sink and drains should have a 10″ high splash back at the wall, and the drains should be turned up 4″ at the front and ends. The front of the drains and the sink should be reinforced by having a ½ oval galvanized iron band riveted and soldered to the top edge. The sink should be supported by galvanized wrought iron legs.

The dish-washing machine, the soiled-dish table, and the pot sink should be connected to a water-cooled grease trap designed to catch the grease and allowing it to congeal therein instead of in the sewer pipes, thus reducing the danger of having them stopped up.

The Tray and Glass-washing Sink. — The tray and glass-washing sink should be made of the same material as the pot sink and should be constructed on the same plan, except that, instead of using a standing overflow waste plug in each compartment, a ground plug and chain should be fitted. The size of each compartment should be about 24″×24″×17″, this being of proper size to accommodate the 17″×22″ trays, which is the size commonly used.

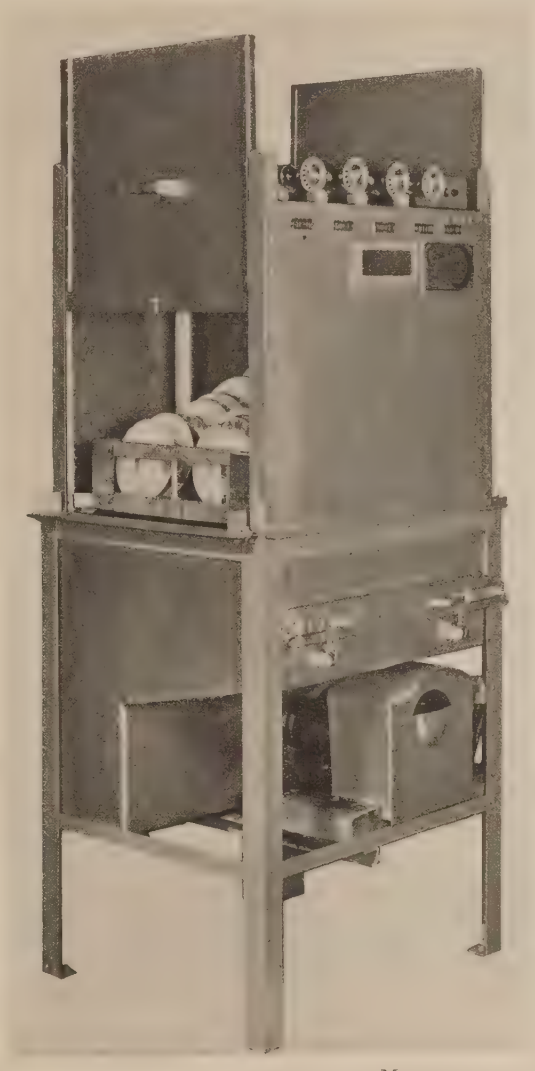


Fig. 445. — Small Dish-washing Machine.

The Storeroom. — The storeroom should be placed adjacent to the kitchen. It should be of sufficient size to store all supplies necessary for a period of at

least thirty days, except those articles which can be taken care of in the refrigerator. A storeroom of this kind should be about 30′×30′. It should be well ventilated and, if possible, lighted by natural light. The walls and ceiling should be finished in hard wall plaster or like material, and the floor finished in white tile or cement with a sanitary base. A line of shelves 20″ wide should extend from the ceiling down each side of

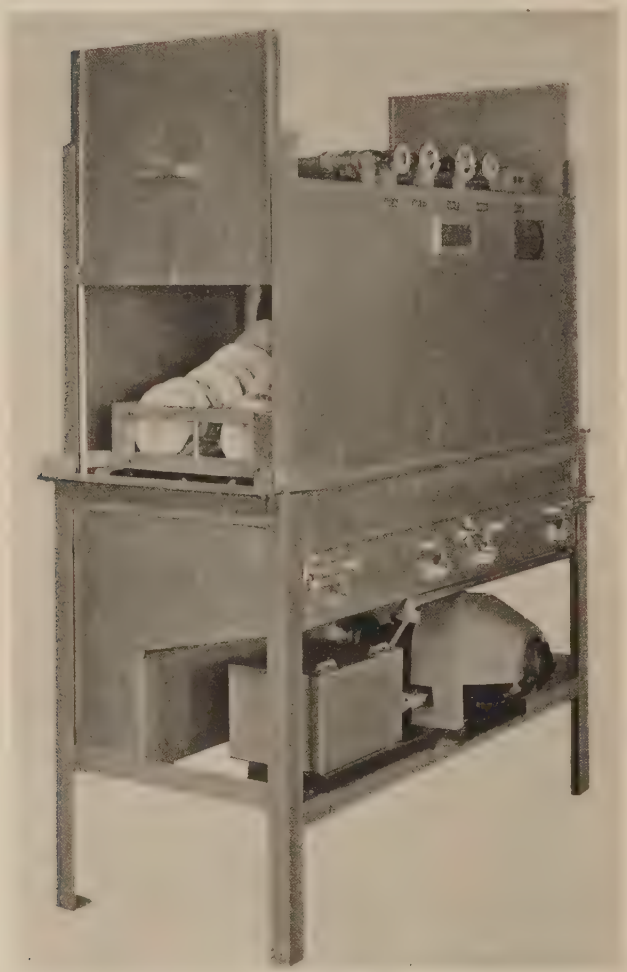


Fig. 446. — Large Dish-washing Machine.

the room, and another line down the center. Under each set of shelves and 32″ from floor should be placed a counter top about 2′ 6″ wide, under which it is a good practice to accommodate a number of portable bins for the storing of loose cereals, beans, peas, etc. These bins are made of either galvanized iron or wood, and are equipped with rubber-tired wheels so that they may be rolled out to any location when it is found necessary to refill them or to scrub the floor.

The Cold-storage Room. — This room should be roomy enough to store supplies for about three days, and should be divided into three compartments: one for meats, one for dairy products, and one for fruits and vegetables. The meat compartment is usually of dimensions about 8′ 6″×6′ 0″×6′ 6″; the other two compartments about 5′ 0″×6′ 0″×6′ 6″. The three should be finished on the inside with a good grade of cement or white glazed tile. When these materials are not available, a suitable interior may be had by using a good grade of white spruce, T and G, giving it three coats of boiled linseed oil and rubbing it well between the coats. The meat compartment should be fitted on two sides with 14″ wide removable latticed shelves and on the other side with a double row of removable tinned meat hooks. The other compartments should be fitted with removable latticed shelves on one side only, leaving the other sides free for the storing of boxes, etc. The ice compartment should occupy all the space above the food compartments. Behind the refrigerator, there should extend a hallway into which the door of the compartment should open, thus eliminating the necessity of carrying ice through the kitchen. An iron hook, fixed in the ceiling above the ice compartment door, makes a very convenient arrangement to which the iceman may attach his tackle in raising the blocks of ice.

The front of the cold storage room should be built flush with the kitchen wall and access be made possible by means of doors opening through the wall into the kitchen. The floor should be laid 6″ higher than that of the kitchen to prevent water from entering the food compartments should any of the doors be left open when the kitchen is being scrubbed. The room should be located as far as is conveniently possible from the range and other cooking equipment. The outside of the refrigerator may be finished to match the kitchen and hallway walls, or in natural woods.

The Dining-room. — The food, after being prepared in the kitchen, is transferred to the steam table in set pots and pans, which are made of various sizes and shapes best adapted to the food to be served. These insets are then placed in the steam table in the dining-room, where the food is kept at the proper temperature during mealtime. This equipment is necessary, for a good meal can very easily become unpalatable if it is allowed to cool so that it will have to be reheated. Trucks for the delivery of food to the dining-room and for the return of soiled dishes are found very useful in many of the larger cafeterias.

The Serving Counter. — The serving counter should be about 50′ long ×29″ wide, and should be arranged to contain the following sections, beginning at the traffic entry: tray and silver table, bread and butter table, salad table, steam table, dessert table, cold-drink table, and last the hot-drink table.

To construct the best type of serving counter for all sections except the steam table and cold-drink table, a frame of wood or iron should be erected in the proper location, and covered on the top and front with 3″×6″ white glazed wall tile, laid in cement on wire lath construction. The server's side of the counter should be left open and should be fitted underneath with a shelf for the use of the servers.

The Steam Table. — The steam-table section should be about 10′ long and set with the top flush with the other sections, the front to be so constructed that the tile will show an unbroken line with the other sections throughout. The top should be made of No. 12 or No. 14 galvanized iron, into which are cut the openings for the insets required by the service. The iron top should be covered with polished nickel silver with the edges well turned under to prevent it from buckling and twisting.

The Hot-water Pan. — The hot-water pan should be about 8″ deep and should extend the full length and width of the top. The pan should be made of cold rolled copper weighing about 2 pounds per square foot. Under the water pan is constructed a compartment for the warming of dishes. This compartment and the water pan should be heated by either gas burners of proper size or by steam coils as the case may be.

The Dish-warming Compartment. — The dish-warming compartment should be provided with tight-fitting doors in order to keep the heat in and exclude the dust.

The Cold-drink Section. — The cold-drink section is constructed in the same manner as the other tiled top sections, except that the top should be countersunk about 8″ deep, forming a pan about 3′ 0″ long×22″ wide. This is for the purpose of holding ice on to which the milk bottles, etc., are placed. There should be a 1″ waste outlet and strainer set into bottom to drain off the water.

The Urn. — Coffee is not as a rule served in school cafeterias except to the teachers, chocolate taking its place. It is therefore desirable to have an urn from which can be served coffee and also hot water for the mixing of chocolate. This urn should contain about 4 gallons of coffee and 10 gallons of hot water.

The urn should be placed on a combination urn stand and cup warmer. The top is constructed the same as the steam-table top, except that the edges are turned up 1″ high all around to prevent dripping to floor. The warming compartment is constructed the same as the steam table and is heated in the same manner. A gas burner is brought through the top to heat the urn, care being taken to properly ferrule the opening in order to prevent leakage into the cups.

Fig. 447. — Arrangement of Dish Tables with Dish-washing Machines.

The Tray Slide. — The whole serving counter must have a tray slide about 8″ wide bracketed to the counter front about 8″ above the top. This rail and bracket, if constructed of dark mahogany, makes a very pleasing combination with the white tile.

The Checking Table. — The checking table, containing the checking machine or cash register, is located beyond the end of the serving counter and so placed that food can be handily checked as it is being taken from the service. This table should also be made of dark mahogany to match the rails and bracket of the serving counter.

The Drinking-fountain. — A drinking-fountain at which the pupils may obtain their drinking water should

be placed at a convenient point in the dining-room not too far from the checker. It should be fitted with a quick-opening and self-closing faucet of a type which requires only one hand to operate. If desired the water can be cooled by connecting the pipes to coils placed in the general refrigerator, or a special ice box can be provided. Each entire service must be identical in design and equipment, and the traffic aisles should each be fenced off from seating rooms. The fence should correspond to the other wood construction.

CHAPTER XXV

HEATING AND VENTILATING

By Mr. George E. Reed, M.E.

I. Introduction. II. Standard of Purity. III. Ozonating. IV. Air Filters. V. Humidity. VI. Air Volumes. VII. Cost of Ventilation. VIII. Window Ventilation. IX. Open-air Rooms. X. Stoves. (1) Jacketed Stoves. XI. Furnaces. (1) Defects of Gravity Furnace Systems. (2) Gravity-indirect Steam. (3) Aspirating Coils. (4) Defects of Gravity-indirect. (5) Types of Modern Plants. (6) Furnace Plants in General. XII. Steam Systems. (1) One-pipe Gravity Steam. (2) Two-pipe Gravity Steam. (3) Vacuum Return Systems. XIII. Hot-water Systems. (1) Forced Hot Water. XIV. Apparatus and Design of Plant. XV. Boilers. (1) Boiler Supports and Settings. (2) Boiler Furnaces. (3) Smokeless Boilers. (4) Boiler Location. (5) Smokestack. (6) Oil Fuel. (7) Boiler Room, Piping. (8) Boiler Feed Pumps. (9) Vacuum Pumps. (10) Lubricators. (11) Exhaust Steam. Danger from Oil. (12) Domestic Hot-water Heaters. XVI. The Heating and Ventilating Plant. (1) Heating of Special Rooms. (2) The Indirect System. (3) Air Intake. (4) Intake Dampers. (5) Heating Coils. (6) Fans. (7) Motors. (8) Air Washers. (9) Fan and Coil Connections. (10) Plenum Chambers. (11) The Duct System. (12) Air Inlet Heads. (13) Grilles and Deflectors, Vent Openings. (14) Vent Flues. (15) Roof Ventilators. (16) Roof Dampers. (17) Exhaust Fans. (18) Toilet Ventilation. (19) Temperature Control.

Introduction. — During the past few years mechanical ventilation, particularly as applied to schools and other public buildings, has been the object of rather severe condemnation. A return to the old system of window-ventilation is advocated by many, some of these advocates being men of the medical profession; some are persons with no actual knowledge of the matter, and there are those sincere faddists who cheerfully follow any leader in any direction.

There is no doubt that cause for complaint exists. Not all plants are well designed, and in addition they may be antiquated and incompetently operated. Naturally but little should be expected from them. Many engineers charged with the design of plants are never brought into very intimate contact with the installations after completion and acceptance by the owner, and it frequently may happen that operation faults develop, which are either not rectified at all, or some makeshift is attempted without a real study of the trouble. Sometimes the owner or the architect, from mistaken ideas of economy, will not make the proper provision financially for an adequate equipment. Another source of trouble, and a very great one, has been the lack of interest in the results to be accomplished, but even when the interest is present it is not an easy matter to investigate, follow up, and check the results, especially in the classroom containing numerous occupants in varying states of health, dress, and cleanliness. Investigations and research work are expensive and involve more time and money than is available to the average engineer. There is no doubt that our present systems of ventilation were evolved after the inadequacy of window methods had been demonstrated, and as the majority of the authorities apparently agree that the new systems are at least an improvement over the old, it would seem logical to continue as we are, improving the systems as better methods are made available.

Taking the question of ventilation as a whole, although the great majority of authorities are quite agreed that artificial ventilation is beneficial, they all hold to widely varying theories as to the actual effect heating has upon the air itself, and the hygienic effect of dry or artificially humidified air, of different humidities at different temperatures, of dust, air currents, quantities, carbon dioxide, etc. All these points should be considered in relation to their effects, but since there is no agreement among authorities, any definite theoretical working basis is manifestly impossible, and of necessity the plant in question must be designed along its mechanical phases, and in the light of the designer's experience, past failures, and personal bias.

The comment might be made here that nearly all of the most adverse criticism is centered about public and semi-public buildings. It is probably justified. Take two heating plants each equally good in design and material, one in a school, the other privately owned, and better results will be had from the latter. One does not have to go far for the reason. It is because improperly operated private plants are simply not good business; they do not pay.

Very large industrial organizations have investigated the subjects of heating and ventilating in all their branches and by " stop-watch " efficiency tests have decided what method is best adapted to each given condition. Having decided what system is required, it is then designed with a definite end in view, and it is afterward operated so as to achieve that result.

The Ford Motor Company installed fan ventilation in their great Detroit plant simply and solely because it increased factory output and consequently enhanced earnings. It is not probable that periodically the question is raised as to whether the system is good or bad. The company knew before it was installed.

Silk mills, match factories, and munition plants all have to be provided with some form of artificial humidity control and certain departments must be regulated with extreme nicety, and it is done.

Schools are very remiss in this particular. Even if the plant is provided with all the necessary refinements, use may not be made of them. The man who designs the school heating system has certain things in mind at the time, but unfortunately his connection often terminates with the completion of the building, if not at the time the contract is awarded. The result is that the actual operating supervision is left to the business office, and all the aims and purposes of the designer are lost sight of.

Air is a mechanical mixture containing approximately 21 per cent of oxygen, the balance being composed principally of nitrogen with small amounts of several rare gases and metals. Air as exhaled contains about 16 per cent of oxygen, the difference being represented by products of combustion within the body, CO_2 (carbon dioxide) and water; it also contains various débris from the tissues.

Standard of Purity. — The presence of not more than six parts CO_2 in 10,000 parts of air has been for years, and still is, quite generally considered the proper standard of purity for air in most ventilating problems, the CO_2 having been held to be very injurious. The idea that CO_2 is in itself actually poisonous is now generally discarded in all well-informed quarters. The old standard of six parts in 10,000 is, however, almost universally retained, as it happens that an air supply sufficient to maintain this standard with the outside air at three parts, is about enough to carry off the bodily heat and dilute the various objectionable matters and odors. In other words, CO_2 is really taken as an index to the condition of the air in other respects. The presence of carbon monoxide, however, is distinctly another matter. It is doubtless unnecessary to state that carbon dioxide is the resultant gas obtained by the complete combustion of carbon and oxygen, while carbon monoxide is produced by the incomplete combustion of these two elements. Monoxide is combustible, having power to unite with more oxygen, then becoming, of course, carbon dioxide. The system in the course of its normal functions is constantly giving off dioxide as one of the products of the combustion of the fuels within the body, and even if inhaled it is gotten rid of with comparative ease. Carbon monoxide, however, is a deadly poison. It forms a large proportion of illuminating gas, and is the real cause of the so-called " motor disease " which has recently achieved some little press prominence. The action of carbon monoxide is very destructive, it breaks down the hemoglobin of the blood which constitutes the solid structure of the coloring matter of the red corpuscles and which is the oxygen carrier of the blood.

Ozonating. — Ozone has been advocated quite extensively, and excellent results are claimed by some who maintain that practically all refuse organic matter is oxidized by it. The opponents insist that ozonating air merely covers one odor with another, and that if enough ozone be admitted actually to oxidize the objectionable substances then the odor would not only be unbearable but there would be actual danger of the formation of nitrous compounds. Quite a variety of apparatus is manufactured and sold regularly by very reliable electrical concerns, but in spite of this it is difficult to find warrant for the general adoption of ozonating apparatus in connection with ventilating problems.

Just what effect upon the health is produced by the various excreta contained in exhaled air is not yet established. It is held by some that they are positively harmful, while others claim that they have no effect whatever, barring, of course, direct infection by germs. On the whole, it may be safe to assert that if the relative humidity and temperature be maintained at the proper points, no danger has yet been proven to exist. The actual cause of " crowd poison " seems to be the high temperature and high relative humidity produced by massing people in small spaces or limited areas, either indoors or out. It should be remembered that the temperature of the body must be kept normal and all heat generated by the various processes must be dissipated, and when the temperature of the surrounding air is equal to or above that of the body all this heat must be dissipated by the evaporation of water from the surface of the skin. If the air becomes saturated to such a degree that evaporation does not take place with sufficient rapidity, then the temperature of the body will rise and general disorder will ensue.

Air Filters. — Dust is objectionable in various ways, as a carrier of disease germs, as an irritant to the mem-

branes, and if carried into buildings it soils walls, furniture, etc. Dust can be readily removed by means of air washers if desired. Air filters, composed of a filtering material of coarse texture, either wet or dry, have been extensively used in the past, but are now quite generally abandoned on account of their inefficiency, liability to clog with dust, and the excessive resistance offered to the flow of air when fouled.

Humidity. — The question of humidity is important but difficult to solve. The term "humidity" as used is taken to mean relative humidity expressed in per cent of saturation. The capacity of air to absorb and hold water varies with the temperature, and increases with the temperature. Assuming that the cold outside air be at or near saturation and that it be passed over the heating surfaces without having moisture added to it, the capacity for the absorption of water will be increased, depending upon the final temperature. Since the air after heating has this increased power for holding water, it will take it from all available sources; from the mucous membranes, the linings of the nose, throat and nasal passages, and from the eyes. This naturally leads to inflamed eyes, sore throats, and increased liability to cold infections, due to the parched condition of the membranes. Another effect of low humidity is to increase the rate of evaporation from the skin, with the result that a temperature of 70 degrees, or even 72 degrees, may not feel as "comfortably" warm as a lower temperature and higher humidity. Although lower temperature could be maintained with comfort in humidified buildings, there would be no saving in fuel, since what would be saved by operating on a lower temperature would be more than offset by the amount of heat required to evaporate the necessary amount of water to raise the humidity. If humidifying is undertaken, it should be with the anticipation that it will be an added expense and in no way a saving.

It is not easy to effect a lower room temperature. Many persons are governed by the thermometer and not by their own sensations, and it might be predicted with a reasonable degree of accuracy that were all heated spaces lowered in temperature to say 64 degrees, many of the occupants would feel chilly as soon as they viewed the thermometer, regardless of the degree of relative humidity. Humidifying is not easy in practice. The best percentage has not been agreed upon, and there are some natural difficulties. In cold weather the windows are liable to become foggy, due to condensation, the

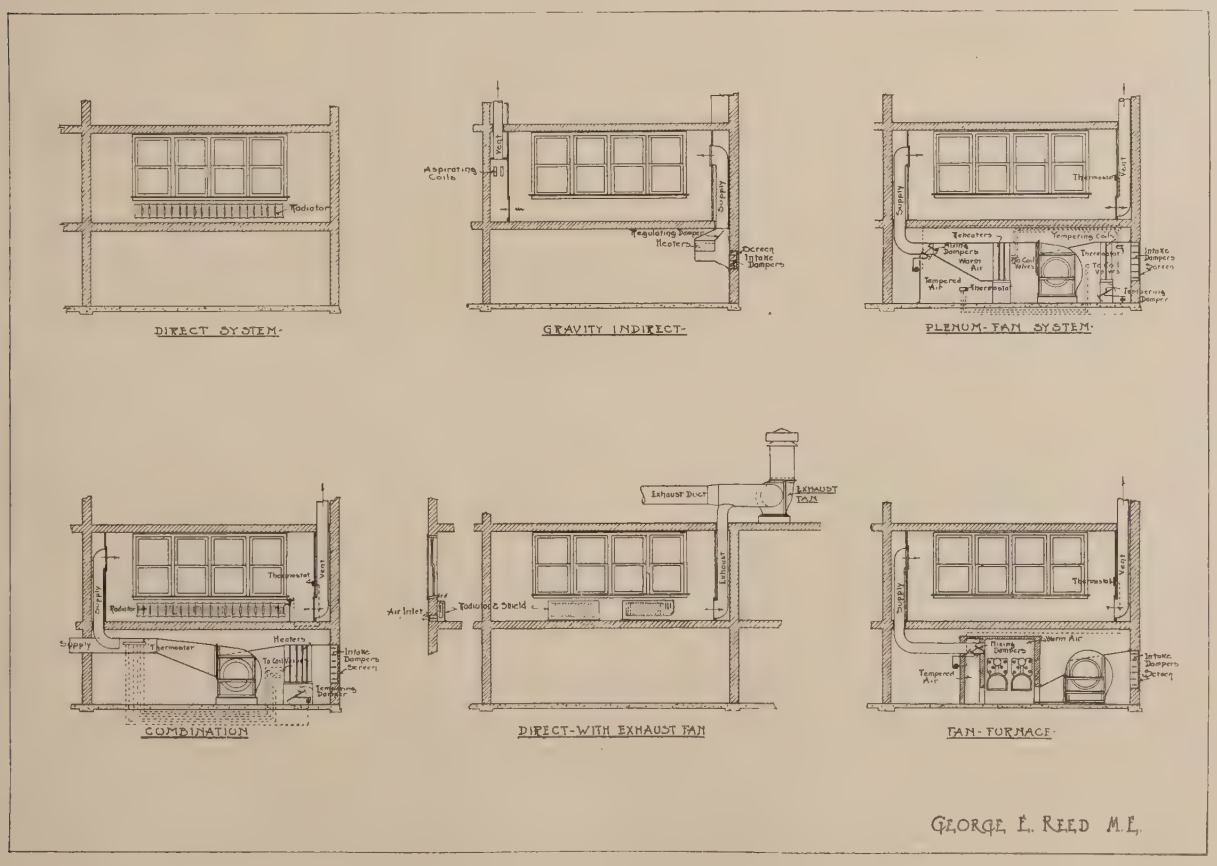


FIG. 448.

books and papers get wet and clammy, and blackboards slippery. While the average degree of humidity is much higher in Portland, Oregon, than in some of the eastern cities, there are periods when it becomes very low, readings sometimes showing as low as 20 per cent.

Air Volume. — Air volume and the location of air inlets are of great importance, as well as the design of the inlet heads themselves. From 25 to 30 cubic feet of air per minute per occupant is about the amount required to maintain a standard of purity of 6 parts CO_2 in 10,000 parts of air, and this is the amount usually required by city ordinance where such obtains. In the schools of Portland 40 cubic feet per pupil is the standard, for the reason that while a smaller amount will maintain the standard of purity, it will not keep the odors down. Air movement is of importance, but hard to control. The warm air entering the room naturally rises, traverses the room more or less uniformly, cools, and drops, passing back through the breathing zone and out through a vent opening near the floor, located in the same wall as the heat inlet. Little trouble is experienced while the incoming air is warm, but as soon as the problem becomes one of cooling instead of heating, the entering air may fall more or less compactly within limited areas near the inlet, resulting in "drafts." The personal equation complicates the situation, because if the air movement is not perceptible some persons will complain that the room is stuffy, while others will complain of draft if they feel any movement of the air whatever.

Cost of Ventilation. — Ventilation is expensive — it takes as much and sometimes more fuel to heat to room temperature the air required for ventilation than to supply the actual heat losses due to transmission through walls and glass. The cost of ventilation can be reduced by recirculating a part of the air, always adding some fresh from outside, say one-fourth to one-third of the total amount, and if the recirculated air is washed, very economical and satisfactory results can be obtained. Recirculating is very generally done in industrial plants, but it is out of the question in schools, for psychological reasons, if for no other.

Window Ventilation. — Window ventilation for schools has been strongly urged, but for reasons which should be obvious it can hardly be expected to supplant the forced system. In the first place, it would be very difficult to get enough direct radiation in a classroom to take care of the heat losses and also heat the proper

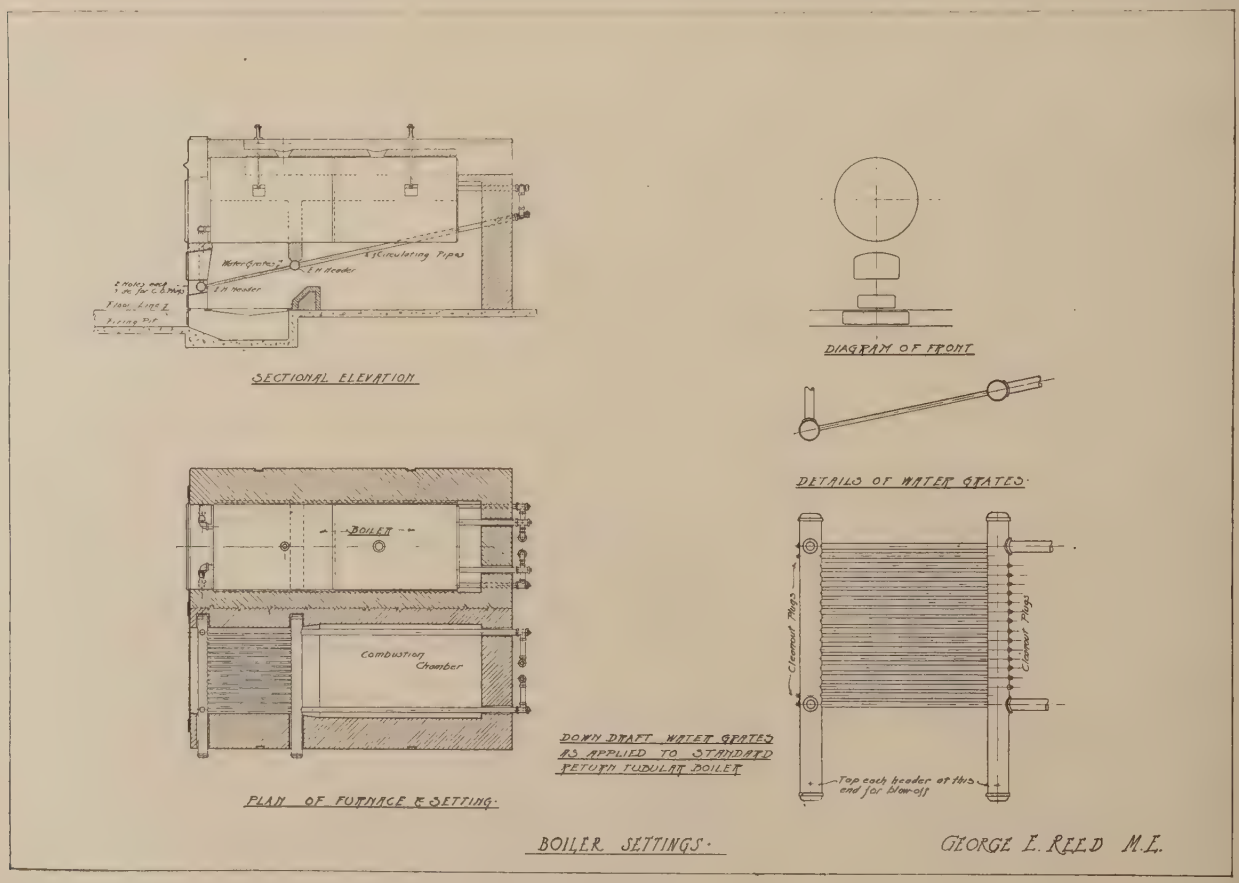


FIG. 449.

amount of air for ventilation. Few classrooms can, for hygienic reasons, have windows on more than one side of the room, and any circulation of air through the room is difficult, if not impossible. On windy days there will be too much air admitted and the seats near the open windows will be cold and those on the opposite side of the room too hot. The leeward side of the building can get no ventilation whatever, due to the fact that it is in a zone of negative pressure, and if it does get any air it is certain to be vitiated air from some other more fortunately located portion of the building. Another difficulty is the prevention of the entrance of snow and rain through open windows, and in very inclement weather the windows are not opened at all and there can then be no ventilation except leakage. Much opposition among occupants of artificially ventilated rooms comes from the fact that they are not supposed to open windows. In a properly designed plant the opening of a few windows will do no particular harm except to waste fuel, and it generally does no good except to the imagination. No air can come in, as the room is under a plenum of pressure, and all air movement will be outward unless there is wind enough to overcome the fan pressure.

No control of humidity and poor control of temperature will be achieved in a room heated entirely by direct radiation. It can also be demonstrated that a plant composed entirely of direct radiation is not cheaper to install, if the same results and capacities are actually provided. The usual comparison is that of a direct system providing for the heat loss plus about three to four changes of air per hour, as against an indirect system with from six to seven changes, in other words, a little over one-half the capacity.

Open-air Rooms. — Open-air rooms and the frank abandonment of any artificial means of heating or ventilating reached a spectacular climax of popularity a couple of years ago, but much less is heard of it to-day. There is no doubt that open-air rooms have their place, which is to care for special cases. Open-air work should be done by specialists, and the children constantly kept under proper supervision as regards dress, diet, etc. It should be noted that open-air schoolrooms were originally applied to children sub-normal in a physical sense, and while excellent results were obtained, it does not follow that like benefits would be achieved by the indiscriminate application of the principle to all schools by the general teaching staff and without especial medical supervision, which would, of course, be prohibitive in cost on so large a scale. It is impossible to find any record of the scientific application of open-air work to normal children, and it no more follows that much good would result than that the indiscriminate application of hospital methods to healthy persons would prove particularly beneficial. The various agitations of the past few years have not been barren of results. There is an awakening both among laymen and among engineers, many of the latter having been in a somewhat comatose state, and there is no doubt that many of the worst features of our systems will be eradicated or at least improved upon.

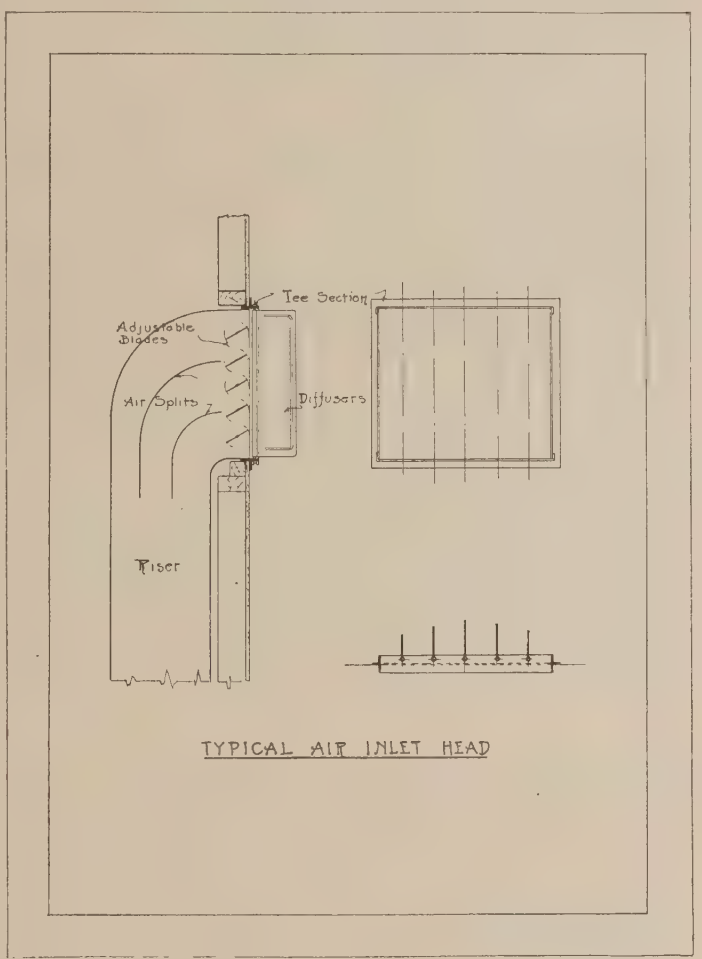


Fig. 450.

Stoves. — The stove as a heating appliance is so simple and so familiar to almost everyone that it is perhaps superfluous to touch upon it in this chapter. Twenty-five or thirty years ago it was in very general use in public buildings and homes alike, and to-day it is by no means uncommon in the country. It is found in the portable schoolhouses of the city, usually in the modi-

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FIG. 451. — BENSON POLYTECHNIC HIGH SCHOOL, PORTLAND, OREGON.

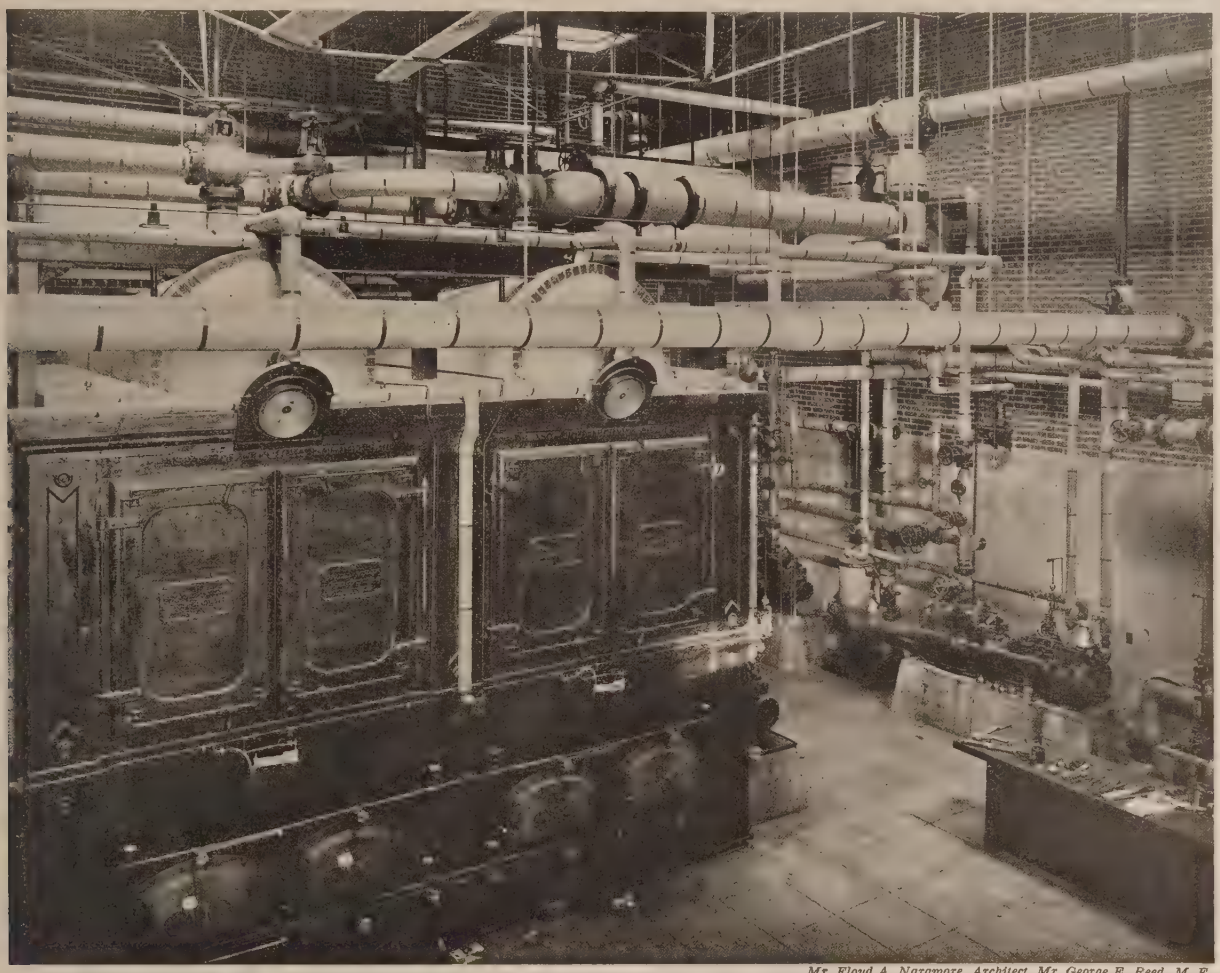
fied form known as the jacketed stove. As a means of heating, the stove is a decided success, particularly in its immediate neighborhood, but inherent limitations confine its use to the very smallest and crudest of school structures.

Jacketed Stoves. — The jacketed stove, in addition to its ability to heat, possesses some powers of ventilation. It consists of a simple heater inclosed in a metal casing, the space between the stove proper and the casing being connected to the outdoor air by means of a fresh air duct. The general arrangement is that of a small house-heating furnace with the top and ducts removed. The actual ventilating capacity of a jacketed heater is not great, but as the usual portable is not a very tight structure and is exposed on at least three sides, infiltration and leakage are sufficient to keep the quality of the air fairly good.

The jacketed stove is a great improvement over the naked heater. The casing serves as a guard against accident by protecting the very hot surfaces, and less discomfort is experienced in seats near it.

Furnaces. — The greatest single improvement over the stove in its elementary state was the invention of the furnace. All the fires were removed from the several rooms and centrally located in the basement near the fuel supply and where the firing, cleaning, and removal of ashes could be accomplished more satisfactorily. The concentration of a number of small heating units into a single large one resulted in fuel economy, less labor and attention, better control, and all the operations could be carried on without entering the classrooms. The fire hazard was also greatly reduced. The furnace in one form or another is more generally used than any other form of heating appliance. It is comparatively inexpensive to install and is especially suitable for small buildings since it requires the minimum of skill in operation. The furnace is a variation of the jacketed stove and is wholly desirable in its proper field.

Defects of Gravity Furnace Systems. — Furnace systems are usually of the " gravity " type. All air movement is produced by the tendency of the heated air to



Mr. Floyd A. Naramore, Architect, Mr. George E. Reed, M. E.

FIG. 452. — BOILER ROOM, MAIN STEAM PIPING, BENSON POLYTECHNIC HIGH SCHOOL, PORTLAND, OREGON.

rise, and this tendency of necessity varies with the degree to which the air is heated, and with temperature of the outdoor air. The greater the difference between the temperature in the heating risers and the outside, the more will be the air delivery. Long horizontal ducts between the furnace and bases of risers affect the air flow unfavorably and the direction of wind is a factor as well. In a still day the system may act perfectly, — given a strong wind blowing directly into the fresh air intake, gusts of cool air are sometimes felt at the heat registers, having passed through the furnace so rapidly that they were not heated. On the other hand, if the wind is in such a direction that the intake is located on the lee side, the proper air movement may be reversed and the warm air pulled out of the building through the cold air connections. These characteristics are probably familiar to all who have ever operated the average house-heating furnace.

Since the ventilating effect is a direct result of temperature difference within and without the heating riser, it should be apparent that in mild and warm weather this effect will be slight or nil. In other words, a gravity furnace will heat and ventilate in cold weather, it will warm the building when it is mild outdoors, but in warm weather it is of no avail for ventilation.

This shortcoming of the system being recognized, the next step was to provide some means of removing the air from the building, which would be independent of external conditions and of the main heating plant proper.

The earliest attempt within the recollection of the writer was in a school which he attended in Massachusetts some twenty-five or thirty years ago. This building was provided with a large exterior brick stack, at the bottom of which a coal fire was constantly burning, which created a strong natural draft. The vent flues from the classrooms were connected to the stack, and the rooms could be more or less ventilated at all times. This system was extremely wasteful of fuel, and the fires in the vent stack consumed as much as, if not more

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FIG. 453. — BOILER ROOM, METERING HEATER, BENSON POLYTECHNIC HIGH SCHOOL, PORTLAND, OREGON.

fuel than those on the grates of the furnaces which did the heating of the building. This method of air removal was the forerunner of the " aspirating coil," and neither should be recommended on account of high fuel consumption.

As the iron and steel industry developed, boilers came into general use, steam and hot water became very strong competitors of the furnace, and finally eliminated it altogether except for small buildings or those where low first cost predominates. This was due in the main to two reasons. In the first place, a furnace must be absolutely tight in all its joints, else trouble will be experienced from smoke and dust finding their way into the air passages and thence to the building. It is next to impossible to construct a furnace so that it will neither burn through if of steel, nor crack and warp if of cast iron. In either case the result is a leaking furnace and soiled building wall surfaces. The second reason for steam supplanting furnace heat was that the rooms, if heated by steam, could be located within any reasonable distance from the heater, while with furnaces long horizontal ducts meant bad air distribution.

Gravity-indirect Steam. (See Figure 448.) — The earlier steam ventilating plants usually consisted of some form of radiation, and differed from the furnace installation in that the hot-air furnace was dispensed with and radiators were placed in the ducts themselves. Sometimes each riser would have its own individual heater, and frequently a number of rooms would be heated by a bank of radiators, each group having its own fresh air intake.

Aspirating Coils. — To remove the air from the rooms when the heating coils were not in operation the vent flues were each provided with a so-called " aspirating coil." (See Figure 448.) This coil served to heat the air in the vent riser duct, causing it to rise and make its way to the atmosphere. This system, commonly known as the " gravity-indirect," was extensively used before the application of the fan to heating problems, and occasionally it is installed to-day.

Defects of Gravity-indirect. — The "gravity-indirect" system is faulty in some very vital points. Being based wholly on the gravity principle, its operation is often hampered by adverse weather conditions, as in the case of the gravity furnace. The movement of air by means of heat applied directly to the air itself is very costly when compared with moving the same amount by mechanical methods such as engine or motor driven fans. A serious defect, though one of operation and avoidable, is that the air valves and traps on the "aspirating" coils may become clogged and the coils air-bound. In this case, and it is not an infrequent one, the coils do not heat, and the room is consequently not ventilated. Fans had been in use many years for ventilating mines, and after going through various stages of development, their application to building problems became more and more general.

Types of Modern Plants. — Modern school heating systems in general are divided into three classes, furnace, steam, and hot water, each having its own peculiarities, advantages, and disadvantages.

Furnace Plants in General. — As stated above, the furnace plant is cheaper to install, somewhat more simple in operation, and may be slightly more economical from a fuel standpoint. In addition to liability of dust, smoke, and gases from cracked or burned furnace sections and leaking joints, it is difficult to heat small service and special rooms without heating the entire building at the same time. This fact often offsets any fuel economy the plant may otherwise attain. In extreme weather the whole building may have to be heated in order to protect plumbing pipes and fixtures, all of which may be located in a few rooms.

In case the building is too large for one furnace, two or more are assembled in battery. This presents difficulties in the way of even distribution of heat to different rooms. No trouble is experienced when the weather is cold, as there is then a fire in each furnace. In mild weather, however, all the fires will not be lighted, and those rooms will not be heated which receive their air supply from ducts leading out from near the cold furnaces, while the other rooms may be too warm.

This is a condition which can be remedied in a degree by the installation of "baffles" and deflectors, but not satisfactorily. The janitor may forget the arrangement and location of these "baffles," and light furnaces which should not be lighted, or repairs may necessitate a different arrangement from that obtaining before.

Complaint is often made of the very dry and "burned" condition of the air from furnaces. There is probably just basis for it, but the reason has not yet been accurately determined. It is possible that the extremely hot surfaces of the furnace radiators burn the impurities in the air or perhaps change in an unknown way some of the vital qualities of the air itself. The writer is of the opinion that low relative humidity is the cause of most of the discomfort.

Steam Systems. — The steam system is somewhat more expensive to install, and requires a higher grade of operating ability. Special rooms, corridors, offices, and toilets can be warmed by direct radiation (see Figure 460), making these rooms available outside of school hours and also permitting the heating of just those portions of the building necessary for the protection of plumbing against freezing, all at a minimum fuel expenditure.

One-pipe Gravity Steam. — The simplest form of steam is the one-pipe gravity, which is usually operated at pressures up to twenty to twenty-five pounds per square inch.

For all but the very largest buildings, where problems of drainage and pipe sizes would render one-pipe gravity undesirable, this system is probably the best-fitted for school work. It is comparatively cheap to install, and its simplicity of construction makes operation easy. It requires little by way of maintenance and is efficient.

The "one-pipe gravity" system is so called because the steam and water of condensation are both conveyed through a single pipe. For this reason the piping system has to be large and high steam velocities avoided. In a horizontal pipe, for instance, the steam flows away from the boiler and the water toward it. If the pipe is too long or not sufficiently large or if the grade too low, the steam may impede or even stop the flow of water, resulting in "water hammer," broken fittings, and split pipe, with consequent damage to building and fixtures.

Two-pipe Gravity Steam. — Two-pipe gravity systems are sometimes installed, in which case, separate returns are taken back to the boiler from the radiators.

Vacuum Return Systems. — The vacuum system is a modification of the two-pipe gravity. This system gives good results if properly designed and constructed. There are several vacuum appliances on the market, differing only in detail, workmanship, and cost. They are practically alike in principle.

An important advantage of the vacuum system is that the pitch of piping can be reduced to less than that of the gravity, and the returns can be made higher than the radiators if absolutely necessary; but this is bad practice. There are no air valves on the radiators to spit water, and much better control is possible, since the radiator valve may be partly open in any position.

Hot-water Systems. — Hot-water heating systems may be either forced or gravity. In the former the water is circulated by means of a pump, and in the latter circu-

Mr. Floyd A. Naramore, Architect, Mr. Geo. E. Reed, Mechanical Engineer.

FIG. 454. — ENGINE ROOM, BENSON POLYTECHNIC HIGH, SCHOOL PORTLAND, OREGON.

lation is produced by the tendency of the hot water to rise. The gravity hot-water system is admirably adapted for house heating, but it has limitations which prevent its being of much utility in schools. It will not be considered in this chapter.

Forced Hot Water. — Forced hot water is a most satisfactory heating medium. It is agreeable, very flexible and easy to control. It is peculiarly adapted to the heating of scattered buildings. Where the ground is very uneven and the buildings are on different elevations, forced hot water conforms readily to the conditions, as the piping can follow the contour.

This system is relatively expensive, although not excessively so. The cost of a forced hot-water installation should not exceed that of first class vacuum work. Forced hot water requires more attention in design of plant and especially of distribution. The pipe sizes, in general, of a forced hot-water system will usually be about the same as for vacuum under the same conditions. The actual sizes depend entirely upon the limit of friction against which it is desired to pump the circulating water.

Each and every main and branch should be figured as an hydraulic problem, and the nearest size of commercial pipe selected. The too common practice of estimating pipe sizes by some rough and ready rule and then filling the system up with so-called " chokers " should be condemned. Like everything else in the scheme of things " chokers " have their place, but to install a four-inch heating main and then close it off with a " choker " having a two-inch orifice is anything but good engineering practice. Better and cheaper to install smaller pipe.

Great care is necessary in the design of hot-water plants, to the end that no portion of the piping is exposed in such a way as to cause freezing. This can be prevented without difficulty.

Apparatus and Design of Plant. — It might be stated here that there is nothing in the design of a heating plant, of whatever type, which goes further towards

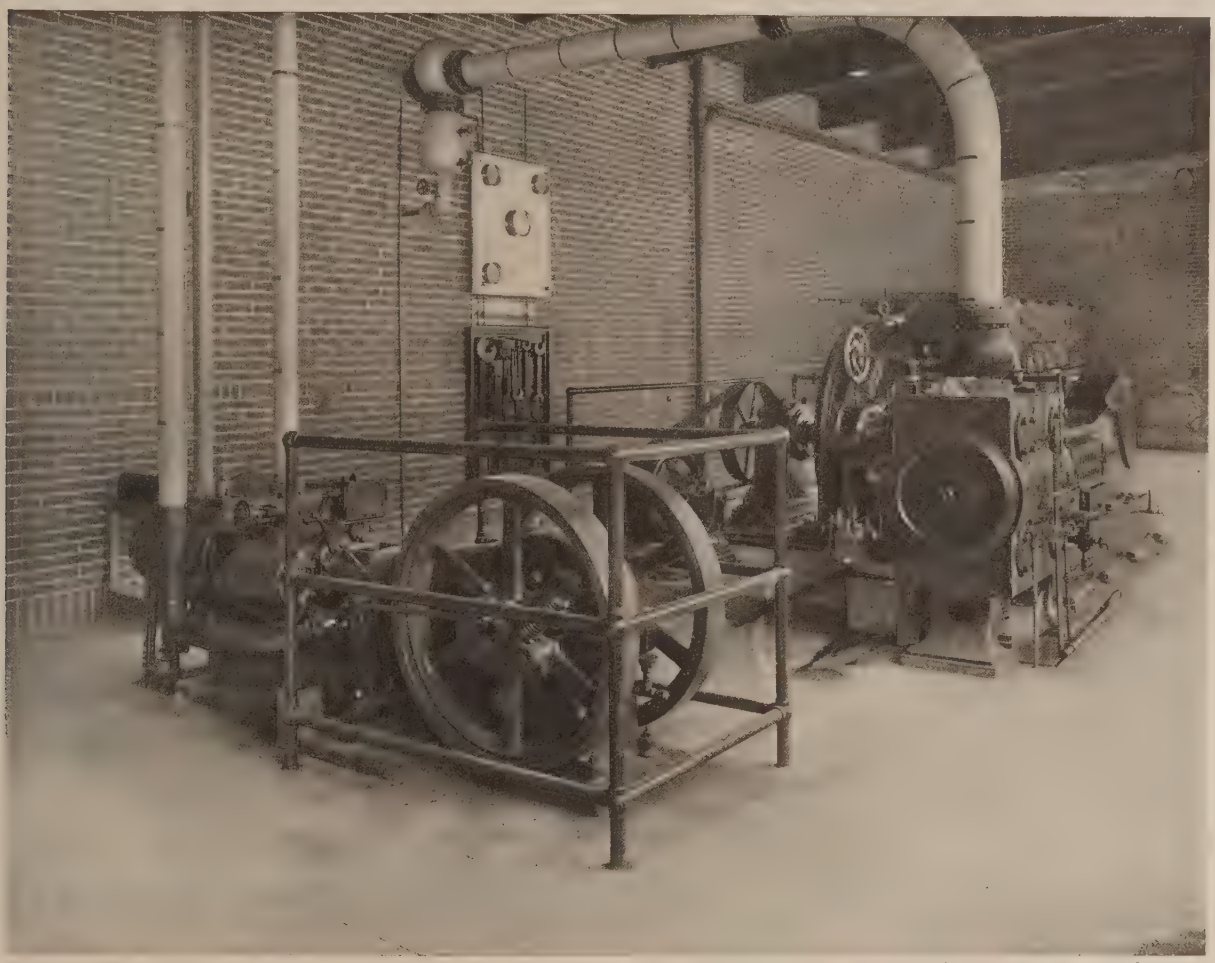

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FIG. 455. — ENGINE ROOM, BENSON POLYTECHNIC HIGH SCHOOL, PORTLAND, OREGON.

promoting satisfaction all around, as well as economy, than simplicity and the elimination of every needless complication. Too many engineers inject all sorts of unnecessary apparatus into the plants intrusted to them for design, with the result that the operating history of an installation is one of repairs, renewals, and general expense to the owner. In general, the simpler a plant is the more efficient it probably will be.

The inclusion of the many patent devices calculated to remove all necessity for brains on the part of the attendant, or to perform miracles in fuel conservation, should be avoided. Many of these contrivances are sold with guarantees which are very broad and binding, but often valueless. Not infrequently the maker or agent will have gone out of business before the buyer discovers that the mechanical wonder does not function.

The selection of the various apparatus of the school plant is a question of vital importance, and one that never should be left to anyone having an interest in the sale of the equipment, either directly or indirectly, or the results may be bad. Every item included in the heating installation should be of high grade and of standard make.

Boilers. — The boiler best suited to general heating work is the horizontal-return tubular, with the exceptions that below forty horse power, a firebox boiler is equally good and cheaper, and for sizes of one hundred and seventy-five horse power and over, water-tube boilers are to be preferred. The return tubular boiler should be designed for a working pressure of one hundred and fifty pounds per square inch, with double butt-strapped joints and charcoal iron tubes. These last two details in normal times cost but little more as compared with a standard boiler, and add greatly to the life and safety of the installation.

Boiler Supports and Settings. (See Figure 449.) — All boilers above one hundred and twenty-five horse power should be provided with a gallows frame, half or full suspension. The practice of carrying all the weight of a heavy boiler on the boiler brickwork is a bad one. It

inevitably results in cracked and broken settings with lowered efficiency due to air leakage, and is apt to be productive of bad strains in the boiler itself as a result of uneven support.

The boiler should be inclosed in brickwork composed of the very best of materials, installed by men skilled in this particular branch of masonry. Every attention should be paid to the proper air spaces, linings, and the protection of structural members and supports from heat.

Boiler Furnaces. — As regards importance of function, the furnace ranks second to no other part of the plant, but it is too seldom that much thought is given it. It can be stated that, as a rule, the furnaces are not large enough as regards combustion space, and it is not often that they are designed with any particular fuel in view.

The greatest fault is that the boilers are contracted for with standard settings, and they are altogether too low for the economical or smokeless use of fuel. The combustion chamber should be increased in height by one to three and one-half feet in addition to the standard height. How much they should be raised depends upon the nature of the fuel and the size and type of boiler.

Smokeless Boilers. — Smokeless operation is practically impossible unless the boilers are equipped with "smokeless" settings or down-draft grates. Both of these, for application to the ordinary-sized plant, have been worked out to a high degree of perfection, especially in Chicago. "Smokeless" settings and down-draft grates, however, achieve their purpose at some cost to boiler capacity.

Boiler Location. — If possible the boilers should be located outside the building proper, for considerations of safety and to facilitate the handling of fuel, ashes, and supplies.

Smokestack. — The breeching and stack are of prime importance. Both should be of ample size to carry off the waste gases, and the stack should be high enough to produce and maintain the draft pressure necessary for good combustion. No hard and fast rule can be laid down for the stack design which will be applicable for all conditions and fuels, since the requirements will vary widely. A low-draft pressure would be satisfactory for fuel oil, but higher pressures must be had if coal is used and particularly a strong coking coal. The stacks of school plants are too often not high enough for good results. This is frequently due to bad design as well as to limitations imposed by the architect.

Oil Fuel. — Crude oil is an ideal fuel, from the standpoint of cleanliness and ease of operation. It is economical if the equipment is properly selected and installed, but its use is limited to a comparatively few localities.

Boiler Room. Piping. — Everything in and about the boiler room should be heavy, and securely installed. All boiler-feed and blow-off piping and all other boiler piping up to the first valve should be extra heavy. It is good practice to make all valves and fittings in the boiler room extra heavy, since it is here that the greatest strains occur. Ample provision for expansion and contraction is a requisite throughout the entire system, but it is especially so in the boiler room.

Boiler Feed Pumps. — Boiler feed pumps of the outside packed plunger type are the most desirable, since any leakage is instantly visible, which is not the case with piston-packed pumps; however, piston-packed pumps are satisfactory for small plants. Boiler feed pumps should be installed in duplicate, each pump large enough to handle the entire plant under maximum load. This will insure low piston speeds, few packing troubles, and long life.

Vacuum Pumps. — Vacuum pumps having a rated capacity of one-third to one-half in excess of maximum figured requirements is good practice and the pumps should be equipped with suction strainers to prevent the entry of dirt and scale with consequent injury to valves and cylinders.

Lubricators. — Forced-feed lubricators are a necessity in all pump installations. The action of boiler feeders and vacuum pumps is intermittent and the forced-feed lubricator supplies oil only when the pump operates, consequently reducing the cost of lubrication. The less oil is fed into the system, the less has to be eliminated. Sight feed lubricators should be installed, however, in addition to the mechanical ones, as a precaution against breakdown.

Exhaust Steam. Danger from Oil. — The exhaust from the steam-actuated auxiliaries may be utilized in the heating system, provided proper means are adapted to remove all lubricants. Oil in boilers is a very serious matter, burned and bulged plates can very easily be the result, and it requires but little oil to do a great deal of damage.

Domestic Hot-water Heaters. — Provision for heating water must be made, and the quantity to be heated will vary with the school, but for the average elementary school with eight hundred pupils, a two-hundred gallon tank containing from twelve to fifteen feet of two-inch brass pipe is ample. Schools having pools or large shower rooms, high schools and trade schools, present problems of their own.

In schools having steam-actuated auxiliaries, it is not a bad idea to arrange the piping so that the exhaust can be utilized in the heaters exclusively, and the condensation wasted to the blow-off tank or the sewer. This means some loss of heat with the condensation, but

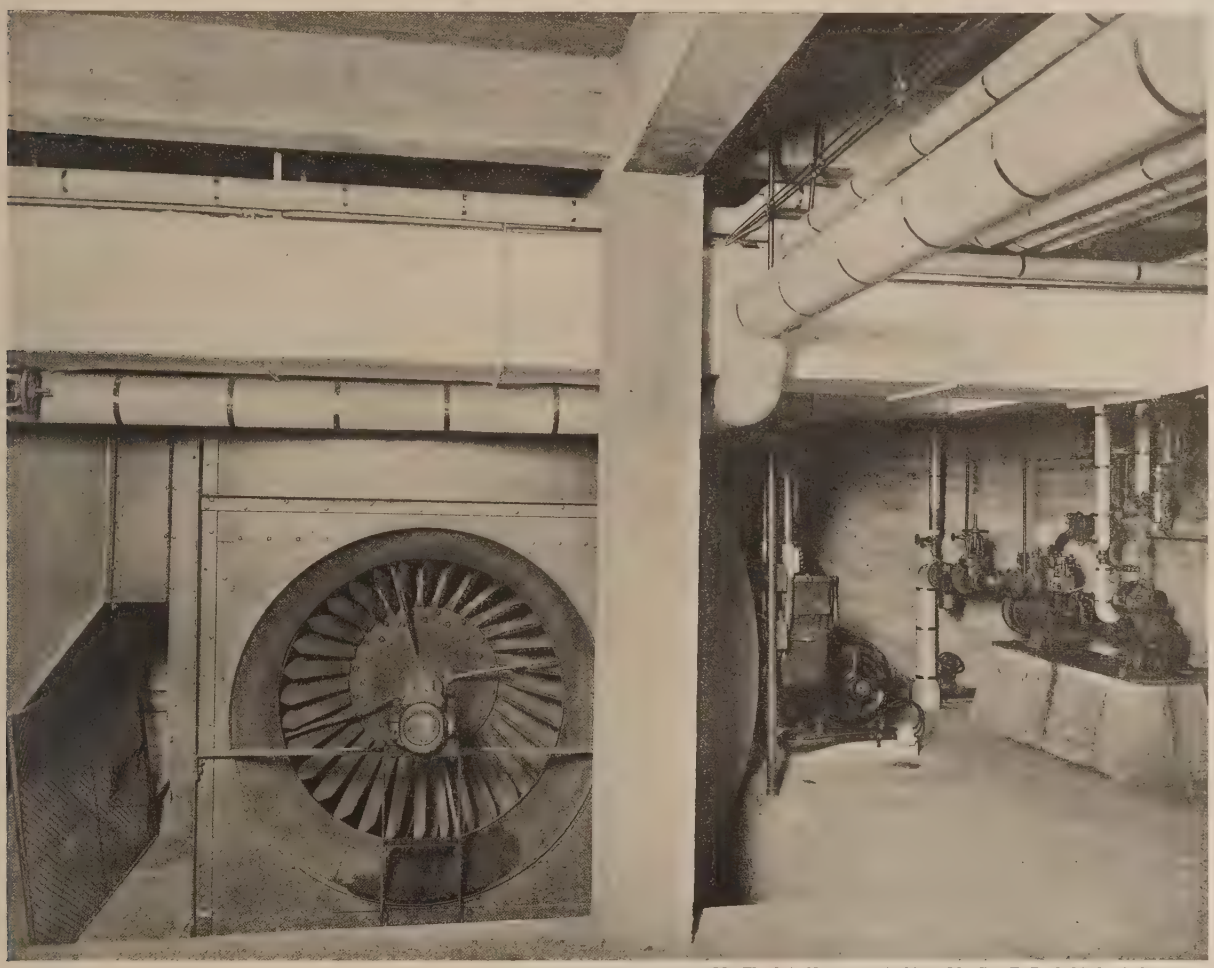

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FIG. 456. — FAN ROOM, BENSON POLYTECHNIC HIGH SCHOOL, PORTLAND, OREGON.

it is probably offset by the increased efficiency of the clean boilers.

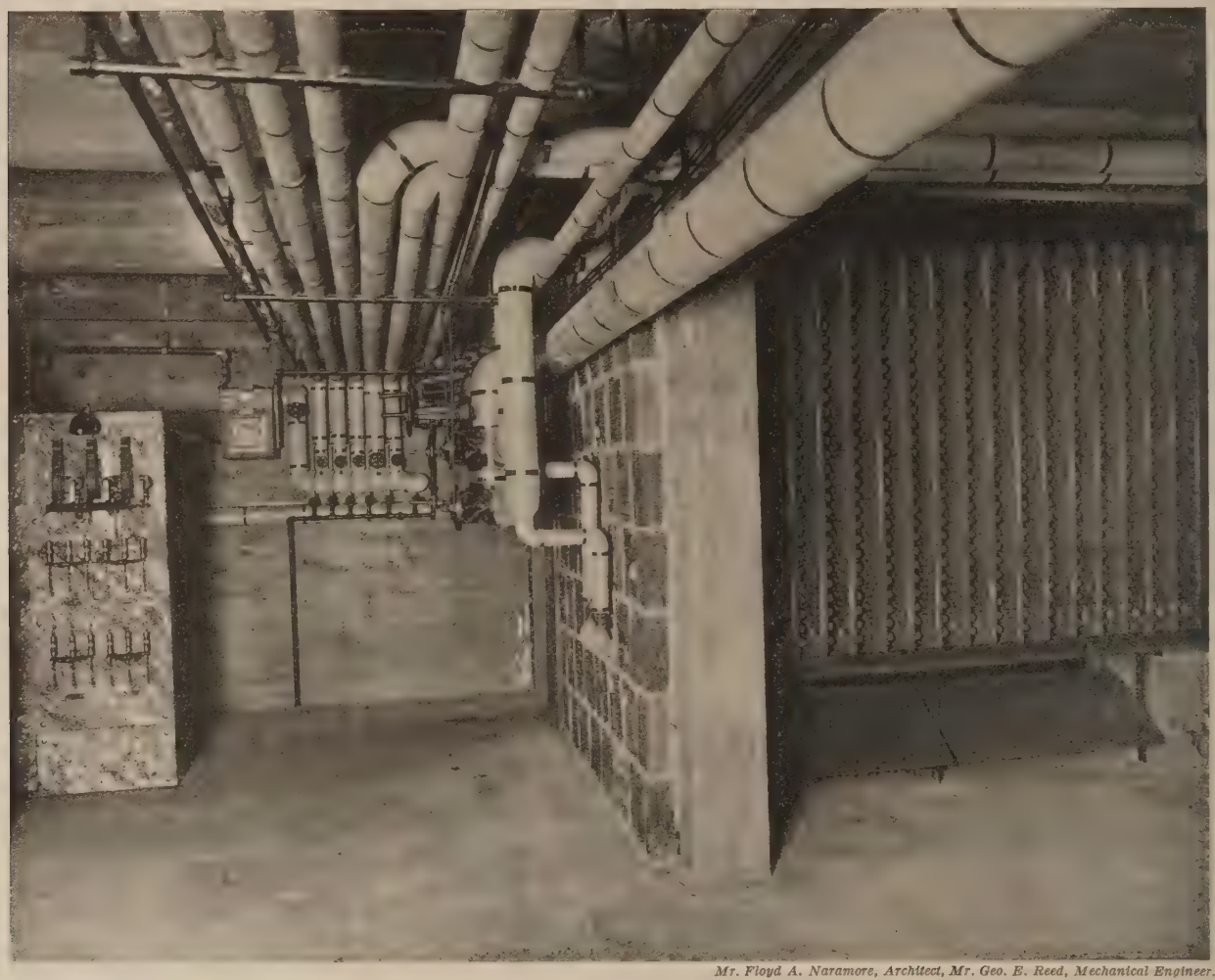
The Heating and Ventilating Plant. — The portion of the system most intimately related to the occupants of the building as regards health and comfort is the heating and ventilating plant proper. Generally speaking, there are two distinct methods; one consists of the supplying of all wall and glass losses by means of direct radiation in conjunction with a fan system arranged to ventilate only, by supplying air at or a little below room temperature. (See Figure 448.) The other system eliminates the radiators and delivers air to the rooms at a temperature high enough to make up for the heat loss through walls and windows. (See Figure 448.)

The first system is more expensive to install, but is better adapted to very low temperatures and is otherwise desirable. Any room can be used after school hours, for community purposes, for instance, without operating the fans. The second system costs less to install, is more simple of operation, and is particularly adapted to those localities not liable to extremes of cold weather.

Heating of Special Rooms. — In either case corridors, toilets, rest, and emergency rooms, principal's office, and other special service rooms, should be fitted with direct radiation hung on concealed brackets, and where the radiator is not located under a window, provided with a metal shield placed behind it to protect the walls from discoloration.

The Indirect System. — The indirect, or fan system, comprises tempering and reheating coils, fans, air washer, galvanized iron ducts, inlets with grilles or deflectors and an appropriate system of vent flues for the removal of the vitiated air from the building.

Air Intake. — The air should be brought into the building through a fresh-air intake, with its inlet not lower than the second story and at a velocity not higher than eight hundred feet per minute. The intake opening should be provided with fixed louvers for the exclusion of rain and snow, and a wire screen. The net



Mr. Floyd A. Naramore, Architect, Mr. Geo. E. Reed, Mechanical Engineer.

FIG. 457. — FAN ROOM, TEMPERING COILS, PLUMBING MANIFOLD, BENSON POLYTECHNIC HIGH SCHOOL, PORTLAND, OREGON.

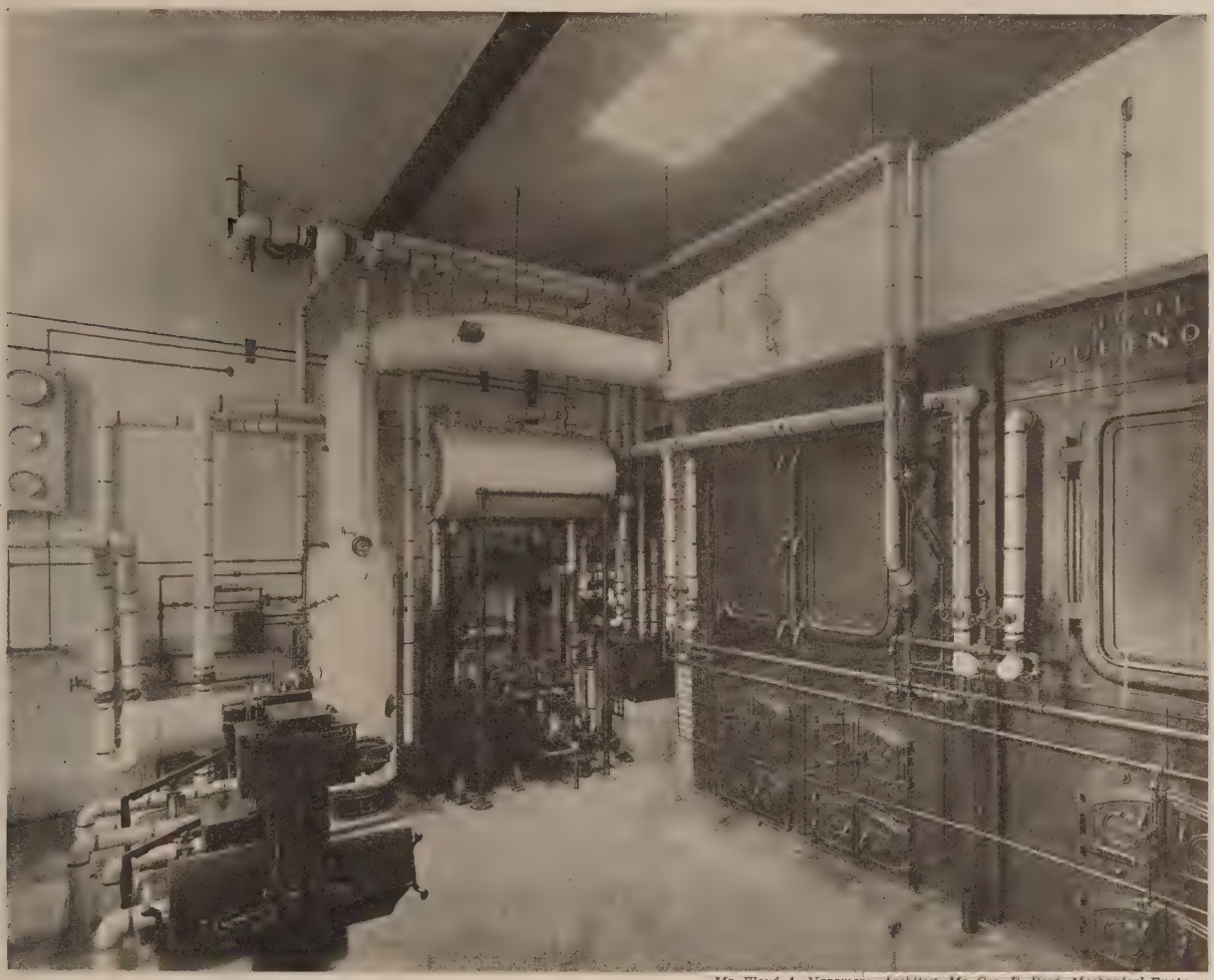
area through these louvers should never be less than the area of the intake itself. This is an important detail, and one that is often overlooked in the drafting room.

Intake Dampers. — Louver dampers in the intake are a necessity, and they may be arranged for manual control or by means of an air switch in connection with the thermostat air compressor; provision should also be made for recirculating air when heating up the building, as this means economy.

Heating Coils. — The heating coils may be either of pipe or of cast iron. Under normal conditions they cost practically the same, and foot for foot there is no difference in efficiency, but the cast-iron heaters present certain inherent advantages. They can be installed in either a horizontal or a vertical position and can be assembled in various desired combinations. The most widely used cast-iron heater is the American Radiator Company's "Vento." It is conservatively rated by the manufacturers and can be obtained in sizes to suit any condition.

Fans. — There are many makes of fans in vogue, but they may all be roughly divided into three groups, steel plate or "paddle-wheel," multiblade, and some form of disc or propeller. The disc or propeller fan is not broadly adapted to heating work, although in small plants and where the resistance is low it answers the purpose. The steel plate fan has been practically eliminated from the heating field by the multiblade, not because it is less efficient necessarily, but because the latter is smaller for a given amount of air and possesses totally different characteristics, which better fit it for use in heating and ventilating.

Substantially all the multiblade fans are developments of the Davison fan; they differ only as to details of workmanship and material. There is one departure, however, in the Buffalo Concidal, which has been developed along lines entirely distinct from any other. It is very conservatively rated, possesses a very uniform delivery of air over the entire outlet, and is quiet in operation. No fan, however, can be quiet if the system



Mr. Floyd A. Naramore, Architect, Mr. Geo. E. Reed, Mechanical Engineer.

FIG. 458. — BOILER ROOM, FRANKLIN HIGH SCHOOL, PORTLAND, OREGON.

is improperly designed. The velocity through the outlet of the fan should not exceed from twelve hundred to fifteen hundred feet per minute, and the total pressure of the fans should not be more than one and one-eighth inch water pressure.

Motors. — Motors should be selected with relatively low relative speeds to insure quiet running and long life. Motor pulleys should be one size larger in diameter than the standard pulleys regularly fitted to prevent belt slipping; this is particularly applicable to alternating-current motors.

Air Washers. — Air washers are a necessity in all localities where the air is smoky or dusty, such as in the congested districts of cities. Country schools, or those located in outlying city districts, need them less, as a rule. An air washer reduced to its prime essentials consists of a tank for holding the water, a series of nozzles for producing a spray, a set of eliminating plates for the removal of entrained water, and a circulating pump. When in operation, the pump draws water from the tank, forces it through the nozzles, where it is broken up into a very fine mist-like spray through which the air is drawn in the process of washing, thus removing practically all solid matter. After leaving the nozzles the water falls to the tank or is caught on the eliminating plates and is recirculated.

The washer may be fitted with a humidifying apparatus consisting of some means of heating the washing water, thus raising the humidity of the air, which is under control of a humidistat. This heating may be accomplished directly by means of a steam jet, or the water may be heated in a closed heater.

For good results the velocity of the air through the washer should not exceed four hundred and fifty feet per minute, and the washer should always be placed on the suction side of the fan and never on the fan outlet, as there is then liability of producing "blow holes" through the mist and considerable quantity of the air will go through unwashed.

Fan and Coil Connections. — Good judgment and

Mr. Floyd A. Naramore, Architect, Mr. Geo. E. Reed, Mechanical Engineer.

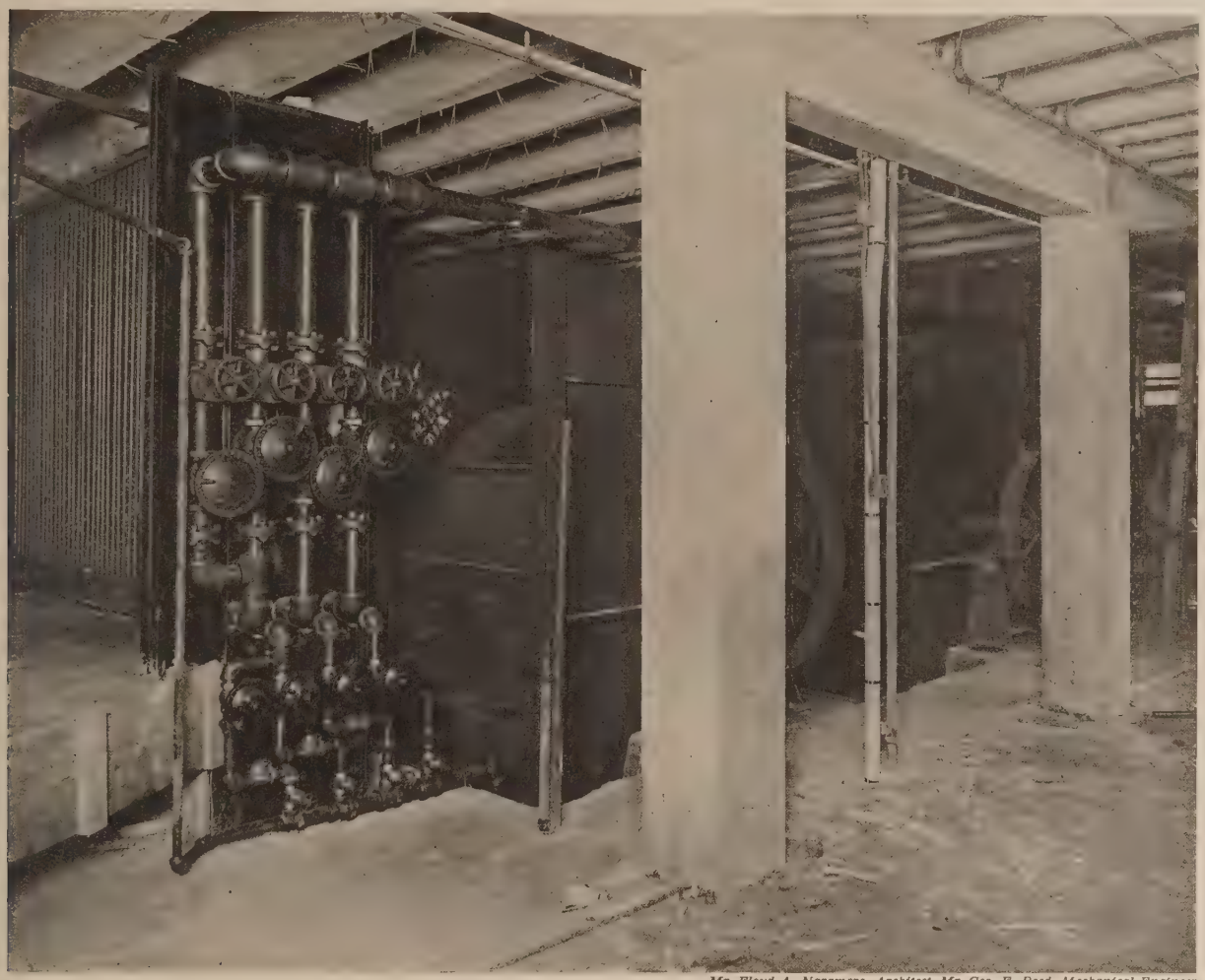
FIG. 459. — BOILER ROOM, CIRCULATING PUMPS FOR FORCED HOT-WATER HEATING SYSTEM, FRANKLIN HIGH SCHOOL, PORTLAND, OREGON.

experience are necessary in the selection of fans, coils, washers, etc., also determining their relation to each other, and to the duct system. The most prevalent fault is short connections between the several component parts. All connections should be long enough to permit of easy air flow, especially the connection between the fan and the reheating coils. If this connection is too short there will be an area of high pressure in the plenum chambers directly in front of the fan outlet, which will tend to force heated air back through the coils at the ends into the tempered air chamber and upset the temperature control. This is the usual cause of "back lash."

Plenum Chambers. — The plenum chambers should be as nearly square as possible, and the velocity across its cross section should not exceed three hundred feet per minute.

The Duct System. — No part of the plant requires more skill in design than the duct system. It may be of galvanized iron, tile, or cement, or in part of all three. Such parts as may be of tile or cement should be ample in cross-section, and all interior surfaces of concrete ducts should be plastered, sharp turns should be avoided, and except where proper provision has been made for them, heating and plumbing pipes and electric conduits should be vigorously excluded from all ducts. The duct system deserves, but does not always get, close supervision during construction. It is not an uncommon occurrence that a good layout is destroyed by poor installation. High velocities in the duct systems should be avoided. One thousand feet in horizontals and four hundred feet in vertical risers is excellent, but not always possible. Each branch or duct should be provided with a damper to balance and control properly the flow of air.

Air Inlet Heads. — Air inlet heads should be located at such height that their tops will be about six inches below the ceiling, and it is advantageous if they be provided with air splits and deflectors to deliver the air uniformly into the room. (See Figure 450.) It not infrequently happens that full duct velocity will be found over an area of from one-half or less of the inlet, and zero



Mr. Floyd A. Naramore, Architect, Mr. Geo. E. Reed, Mechanical Engineer.

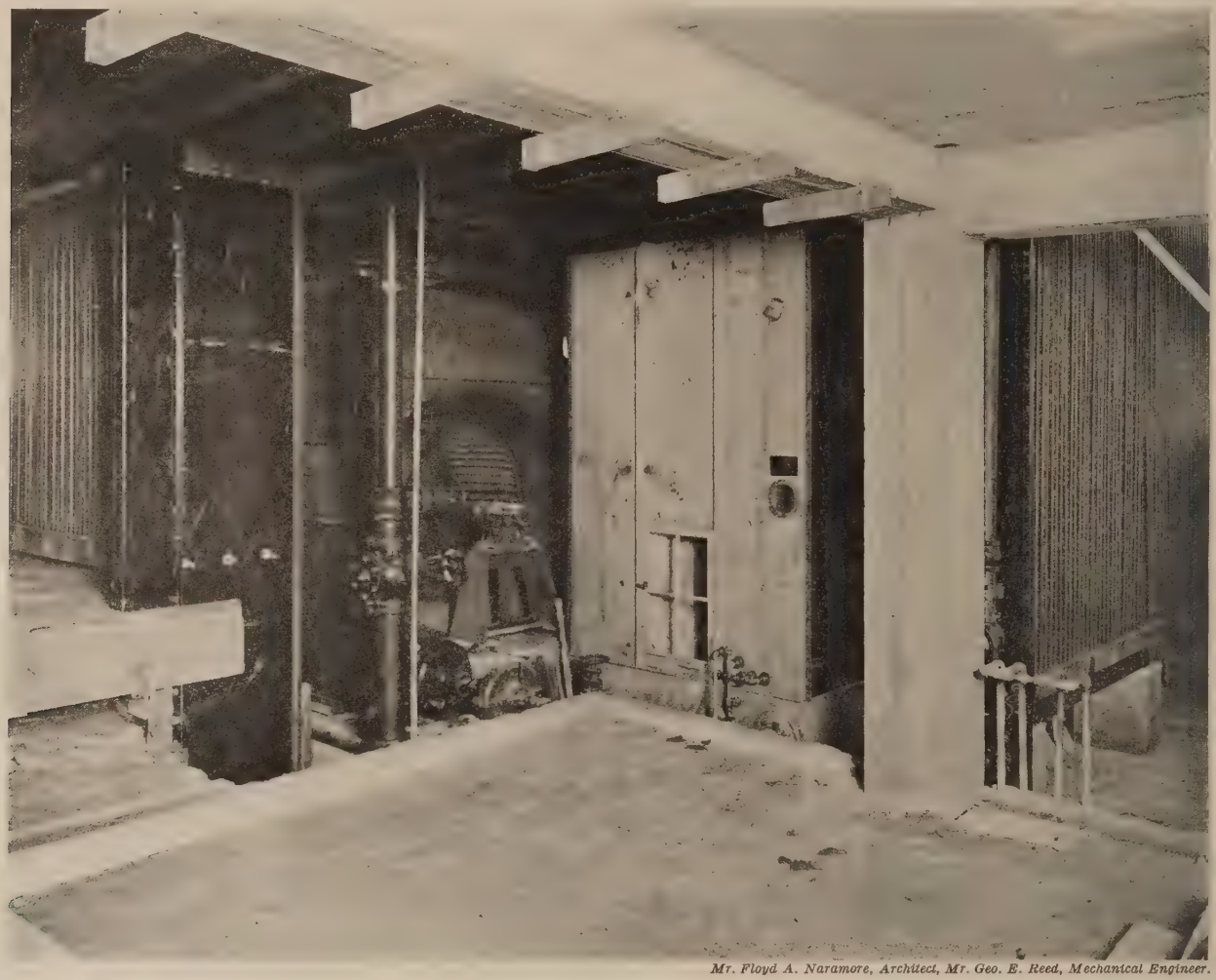
FIG. 460. — FAN INSTALLATION DURING CONSTRUCTION, NEW COUCH SCHOOL, PORTLAND, OREGON.

or negative velocity over the remainder. A velocity of three hundred feet per minute should not be exceeded through the air inlets.

Grilles and Deflectors. Vent Openings. — Except where reasons of design render grilles desirable, their use has been abandoned by the Portland public schools, either for supply or vent openings. In this place it is now customary to install adjustable exterior deflector blades on the air inlets, as they permit of a much better distribution of the incoming air. The vent openings are brought to the floor line and are neatly finished by running the wall and base around the back of the vent and laying the regular flooring on the bottom. The usual grille presents an unnecessary amount of friction to the egress of the air and it is difficult to prevent the accumulation of dirt in the space behind it, while the open vent is easily kept clean. The open vent is liable to this objection, however, that unless rules are made and enforced, it is liable to become a favorite storage space for the waste-paper basket, lunch boxes, books, etc.

Vent Flues. — Gravity vent flues should never be smaller than the corresponding supply risers of the rooms to which they are connected, and it is better, but not always possible, to construct them one-fourth to one-third larger in area. They should be run without bends or offsets direct to the roof ventilators. The practice of terminating room vents in the attic spaces and then providing one or more large ventilators for the attic has nothing to commend it. Nine times out of ten it will be found that if a corridor door or window is opened in a room, the air will promptly back down through the vent into the room concerned.

Roof Ventilators. — In the Portland schools the vents are run separately through the roof, with the provision, however, that where two or more vents are located side by side, they may be terminated in a single ventilator, but in all cases the ducts themselves are kept separate all the way up. Vents from toilets are never combined with any other vents, but are provided with their own independent roof ventilators.



Mr. Floyd A. Naramore, Architect, Mr. Geo. E. Reed, Mechanical Engineer.

FIG. 461. — FAN INSTALLATION DURING CONSTRUCTION, NEW COUCH SCHOOL, PORTLAND, OREGON.

Roof Dampers. — Every roof ventilator is provided with a damper having compressed air control from the engine room, except those from toilets which are provided with neither dampers nor controls. Dampers in the roof ventilators are a necessity, and when used in conjunction with the louver dampers in the fresh air intake, the combination permits of keeping the building much warmer overnight and facilitates quick warming in the morning. If air is recirculated while heating up these dampers for closing, the room vents are a necessity.

Exhaust Fans. — Exhaust fans are limited in their application to the school building. They should be installed, however, in connection with toilet rooms, swimming-tank and locker rooms, and sometimes the auditorium. The extension of the exhaust system depends upon the space for vents in the departments and facility for running the vent flues to the roof.

Toilet Ventilation. — The best way to ventilate the main toilet rooms is through the plumbing fixtures by means of the local vent, sometimes called the " Boston " vent. In this system an air chamber is provided behind each bank of toilets and urinals, from which the air is continually exhausted by a fan. A connection is made between each fixture and the vent space, and the fixtures are provided with air openings through which the air passes. With this type of installation there need be no odor whatever in any toilet room. It might be said in passing that any attempt to accomplish this by connecting the vent chamber with the chimney space is doomed to certain failure, for it will not work.

Temperature Control. — Automatic temperature regulation is a necessity in the modern school. It promotes the health and comfort of the occupants and conserves fuel. Any form of hand control is a failure. If it is attempted it can lead to but two results. Either the person to whom the hand operation of such control is intrusted will manipulate it for his or her own personal comfort, or else it will be neglected in the press of other duties. In either case the results are bound to be unsatisfactory.

CHAPTER XXVI

PLUMBING

By George E. Reed, M.E., *Member of American Society of Mechanical Engineers*

I. Introduction. II. Mains. III. Excavation. IV. Main Soil Pipe. V. Cesspools. VI. Septic Tanks. VII. Roof Drains. VIII. Temporary Toilet Facilities. IX. Materials. X. Underground Pipes. XI. Constant Inspection. XII. Union Connections. XIII. Valves. XIV. Wall and Floor Plates. XV. Floor Drains. XVI. Testing. XVII. Water Supply. XVIII. Water Distribution. XIX. Hot-water Circulation. XX. Fire Protection. XXI. Standpipes and Fire Hose. XXII. Pipe Covering. XXIII. Plumbing Fixtures.

Introduction. — The plumbing system of a modern building is far from being the simple affair it was twenty years ago, although there is nothing involved in it that could not be readily understood by anyone of ordinary intelligence. It is probably true that less care is taken in the design of a plumbing installation than is the case with almost any other branch of the mechanical equipment. In the olden days of lead plumbing and wiped joints, the plumbers' trade, as it is to-day to a less extent, was a closely regulated one, and the journeyman did not divulge much information regarding his art to the layman. City ordinances and regulations generally have never permitted anyone not duly licensed to do any plumbing work extending beyond very minor repairs, and every plumbing installation is subject to strict inspection by the city authority. This is perfectly right and proper, but it has resulted in making engineers and architects careless in regard to plumbing plans and plumbing specifications. Very often, even for large buildings, no plans for the work are prepared, and the specifications are the flimsiest sort of a pretext. Rambling through page after page of semi-technical text, describing weight and quality of material, how to make and calk joints in cast-iron pipe, how to join wrought to cast-iron pipe, etc., the specifications will set forth two things: that the entire system must comply with city ordinances, and it will include with some certainty a list of plumbing fixtures.

There are many things that can make or mar a plumbing installation, and the specifications and plans should be so contrived that the former will be included, and the latter excluded. It is very easy for a plumbing contractor to comply with both the city ordinance and the contract documents, and yet skimp the work in many ways, that is, unless it has been definitely planned beforehand and what was wanted explicitly shown or stated.

Usually the plumbing codes do not embrace anything outside the sanitary system proper, and the entire water distribution, which is vital to its satisfactory operation, is left to the contractor.

The defects which will make themselves known after work is done under these conditions and a strong competitive system are too many to be enumerated here; their name is legion. The chief one is inadequate water supply to fixtures; sometimes twenty to twenty-five flushometer valves will be supplied through a $1\frac{1}{4}''$ pipe run a long distance from the main.

It is not the intention of this chapter to enter into a history of the development of plumbing as a science nor to include all the data necessary for the design of plumbing installations in general, but rather to emphasize those details which are most frequently overlooked or which may not be regulated by law.

Mains. — The first requisite in the intelligent planning of a plumbing layout is an accurate survey of the building site. This should show all the adjacent sewers, water and gas mains, their respective sizes, distances from curb and lot lines, manholes, elevations referred to official datum, and if possible, the location of all stubs and branches. Where there are buildings on the site having connections to sewer, water, or gas, and which will be moved or demolished to make room for the new structure, provision should be made for disconnection and removal of all old service pipes and for sealing of openings in street mains. This is not unimportant, particularly with hard surface streets. It may save an extra expense caused by having to do it after the building is well under way or completed and all other street work done.

Excavation. — Excavation for the underground system is usually done by the plumbing contractor, and care should be exercised that no trench or other excavation

is made close enough to footings or bearing walls to affect them.

Main Soil Pipe. — The main soil pipe and branches should be run with standard pitch, which is usually one-quarter inch per foot. The fall can be reduced to one-eighth or one-tenth inch per foot, provided that permission can be obtained from the proper authorities. This expedient, however, should never be resorted to unless absolutely necessary on account of high sewer elevations. It should never be done merely for the sake of connecting to a conveniently located sewer, and at its highest part or start, the top of the drain pipe should not be less than one foot below the bottom of the floor slab.

The Portland Public Schools invariably connect to the sewer wherever there is any possibility of so doing, even though it entails considerable cost. In one school a distance of about eight blocks was traversed before establishing sewer connection. Neither a cesspool nor septic tank is installed except as a last resort. If the sewer is so far away or its elevation such that connection to it is impossible, then one or the other may have to be constructed.

Cesspools. — If there is a good depth of gravel, and if the surface water stands well below the grade, a cesspool is the better, otherwise a septic tank with loose joints subsoil drain. Cesspools are five feet in diameter and range anywhere from twenty-five to fifty feet in depth. They are lined with brick laid without mortar, the tops being arched over.

Septic Tanks. — Septic tanks are used where neither sewers nor cesspools are practicable. A septic tank based on seventy gallons per day per person and an actual capacity of one cubic foot for every twenty gallons is usually sufficient. The depth of liquid and width of tank may be made roughly equal, and the length twice the width. The depth of liquid should not be less than five feet.

Roof Drains. — Roof drains should never be connected into the septic tank, but rather to dry wells if possible. In fact, the rain-water system and the house drainage system should always be kept entirely independent one from the other. Even where there are sewer facilities, all roof drains, except for small buildings, should go to the sewer direct. If the downspouts connect to the house drainage system, there is liability of backing up at the floor drains during a heavy downpour, and in case the building connects to a septic tank the sudden high rate of flow may entirely displace the contents of the tank, thus interfering with septic action. If the

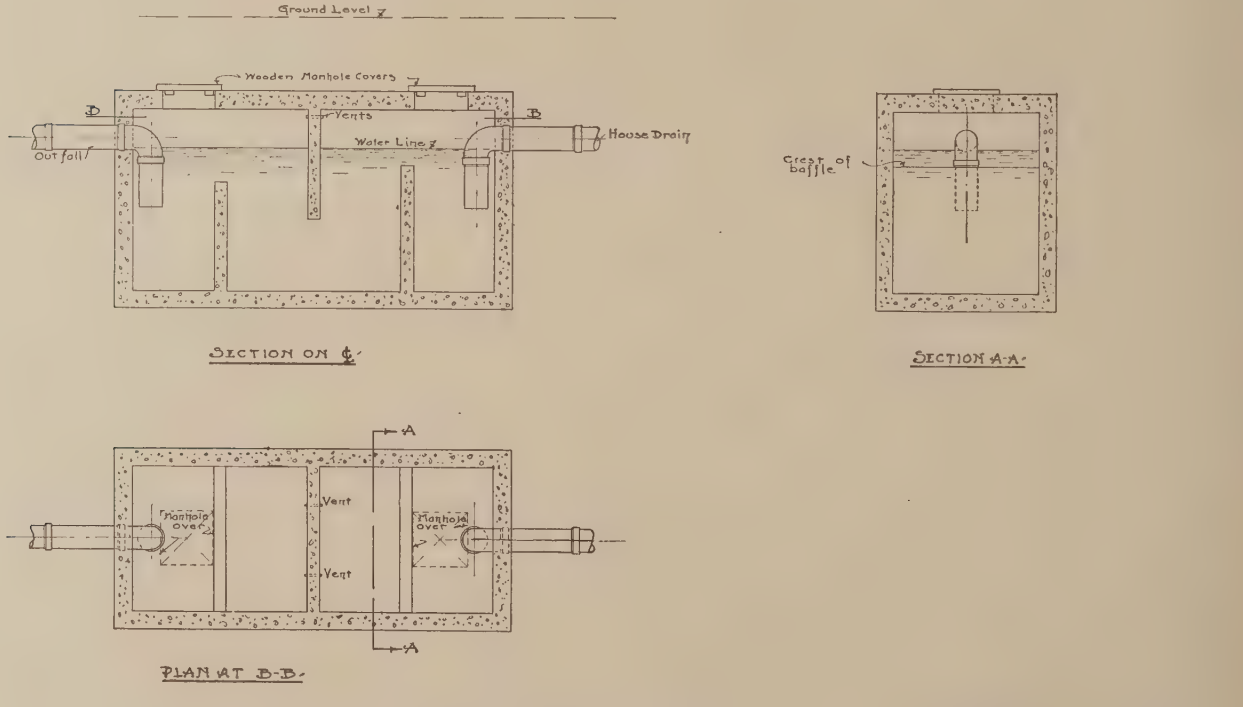


FIG. 462.

FIG. 463. — CLAWSON ELEMENTARY SCHOOL, OAKLAND, CALIFORNIA. *Mr. John J. Donovan, Architect.*

outflow from the septic tank be discharged on the surface, the contents thus ejected may cause trouble. A case in point was one where, pending sewer construction, the writer installed a septic tank for a group of buildings comprising a large institution. The roof and drainage area were considerable, and the tank discharged on the surface. The roof drains were connected, without permission, into the house system, and during a very heavy rain, the septic tank was scoured out and the contents distributed upon adjacent property with the result that claim was made for damage. Roof water from large buildings should not be conveyed to the cesspool, on account of liability of overflowing the cesspool and backing up through the basement floor drains.

Temporary Toilet Facilities. — Wherever possible it is desirable to have the plumbing contractors make sewer and water connections and install temporary toilet facilities for the workmen employed on the building. There is generally little excuse for the latrine so commonly employed on construction work.

Materials. — All the material entering into the school plumbing installation should be of high grade, and as it is liable to be subjected to hard usage, everything should be heavy and substantial. Many cities require by code that all the underground drainage system beneath the building be of extra heavy cast-iron pipe. From five feet beyond the building line to the sewer, salt-glazed vitrified terra cotta pipe with cemented joints may be employed. The "Durham" system of piping with galvanized wrought-iron pipe and recessed drainage fittings is best adapted to all portions of the sanitary system. Cast iron is sometimes employed throughout on account of lower cost, but it is more bulky, and the saving usually is not worth the sacrifice in space and appearance.

Naturally galvanized-iron pipe should be used throughout for all water piping, and malleable iron, beaded, and galvanized fittings should be employed. Gas and vacuum sweeper piping require black pipe, uncoated drainage fittings for the vacuum, and malleable iron for gas.

Underground Pipes. — Under no circumstances should wrought pipe, either black or galvanized, be laid underground, particularly within the confines of the building.

Mr. John J. Donovan, Architect.

Fig. 464. — Boys' Toilet Room, Showing Urinals, Clawson School, Oakland, California.

It will invariably result in early failure of the pipe so installed, and then will arise the necessity of digging up the basement floor to locate and repair leaks. If natural causes do not combine to destroy the pipes, then electrolysis, present in every city, will do it.

The entire water distribution system, both hot and cold, fire protection piping, and gas should be run above ground, exposed if necessary. Something may have to be sacrificed in appearance, but it will pay in the end. In case, however, that a water supply main be four inches or more in diameter it may then be of cast iron and laid underground. An added advantage of having the piping installed as above indicated is that the runs of all pipes are readily followed, and in case of alterations, connection can be made at any time.

Constant Inspection. — Constant inspection should be maintained to prevent haphazard installation of pipes. Plumbers in the usual pursuit of their trade employ a great many forty-five and sixty degree fittings, and unless prevented, these may be too freely installed, to the detriment of an otherwise neat installation. These angle fittings are a logical and necessary part of the drainage system, but their use in other parts of the plant can easily be abused. For instance, if the work does not "line up" properly at some point it can be made to do so by "two forty-fives" and the result is a "skewed" run of pipe. Pipe runs should be run parallel to walls or ceilings unless there are good reasons to do otherwise.

Union Connections. — The use of "long screws" with running threads and lock nuts is not permitted in the Portland schools. They do not make a satisfactory nor permanently strong joint. Except on large sizes of pipe, and at apparatus which might require disconnection at any time, right and left couplings are insisted upon. On apparatus, railroad unions are installed, or flanged unions in the case of large piping. No slip joints are permitted on supplies to fixtures, but ground seat unions are used instead.

Valves. — Valves of good material and manufacture should be insisted upon and provision should be made

to the end that every valve installed have its stem packed with some high grade lubricated stem packing. Too many installations are left with the valves packed with lamp wick. This swells when wet, making it next to impossible to operate the valves, especially large ones. Each valve should be plainly marked with a brass tag secured to its wheel with a brass chain, and a chart should be prepared listing all such valves, together with the location and duty of each. One chart may be provided at the building and one should be filed at headquarters. If any valve is so located as to be inside any wall or in the floor, a metal box with frame and cover, all preferably of brass, should be provided with it.

Wall and Floor Plates. — Where piping passes through finished walls, floors, or ceilings, nickel-plated plates should be installed, and these plates should in no case be of light spun material, but of cast metal secured in place with set screws.

Floor Drains. — The floor drains in all cases should be heavy, with galvanized iron body and brass ring and cover; the cover not less than one-eighth inch in thickness, and removable. Hinged covers not secured by screws should be avoided. They are apt to become knocked open, and injury result from some one's being tripped up. Considerable annoyance is frequently experienced in setting and maintaining floor drains in their proper positions during building operations. A very good method is to rough in for the drain and plug the outlet, then set a sheet metal form around it against which the concrete floor is stopped. After the floor is finished the floor drain fixture can be set and leveled, and the hole filled with concrete. This is also applicable to cleanouts.

Testing. — Great care should be exercised to make sure that the drainage system is tight in all its parts, and no piping should be covered up until it has been tested. The methods to be employed in testing are usually prescribed by law in cities of any size. One as good as any is to plug all openings and fill the system with water to the top level of the vents, and watch for any settlement. If the water holds its level for thirty minutes the system may be declared tight, otherwise not. Smoke or air tests may be made where very low temperatures might cause freezing.

Water Supply. — It goes without saying that an adequate water supply should be provided for all buildings. The water pressure in the main to which the service is to be connected should be ascertained; also whether the pressure is subject to fluctuations, within what ranges, etc.

Having the water pressure in view, the service and distribution system should be designed accordingly. Generally speaking, a high school will require a smaller service line than an elementary school. A grade school with morning and afternoon recess, at which times several hundred pupils may all be released at once, will produce a very high peak in water consumption. With seat-operating flushometers this is particularly so, and with some types of valve the pressure at the fixtures may be reduced by excessive demand so that no flushing effect is accomplished, after the procession is well under way. With manually operated valves or with tanks the result will be the same. In the case of tanks there would not be time for them to fill up enough to flush the bowl out after use. The writer has timed toilet use during recess in grade schools and has observed a flushing rate as high as once every eleven seconds per bowl, and that in schools by no means inadequately equipped with toilet facilities.

A common fault in the water distribution of many schools is badly regulated pressure and lack of means to shut off or control fixtures or groups of them. The main water service of course should have a valve at the curb or elsewhere outside the building; this feature is included in the regulations of most serving companies. The water supply line should be brought to some readily accessible location, the boiler room by preference, and it should there terminate in a manifold having separate valved branches to supply the various building requirements. Every branch leading from the manifold should have a valve and drain; the manifold should be drained as well as the supply pipe leading to it. It is excellent practice to collect all these drains together and arrange the piping so that the discharge will be visible. This will guard against accidentally leaving any drain valve open and wasting of water, — a good point if the water is metered.

Water Distribution. — It is generally sufficient if branches be taken from the manifold as follows, one each: boys' toilet, girls' toilet, boiler room, and heating plant, sill cocks, and general building water supply; the last supplying fountains, isolated fixtures throughout the building, such as offices, emergency rooms, teachers' rest room, etc. The hot water may also be included. This branch should be provided with a pressure regulating valve. If this is done less trouble will be experienced with fixtures, and the pressure at the fountains will be constant, or practically so, at all times. If no provision is made for maintaining a uniform pressure at drinking fountains, constant changes in adjustment will be necessary, and even then the results will be far from satisfactory. If regulation is made in the cups so as to prevent spouting during periods of high pressure, the flow will be so small during recess, when the toilets are in full blast, that the drinkers will be obliged to touch the cups with their mouths in order to drink, and direct contagion is possible.

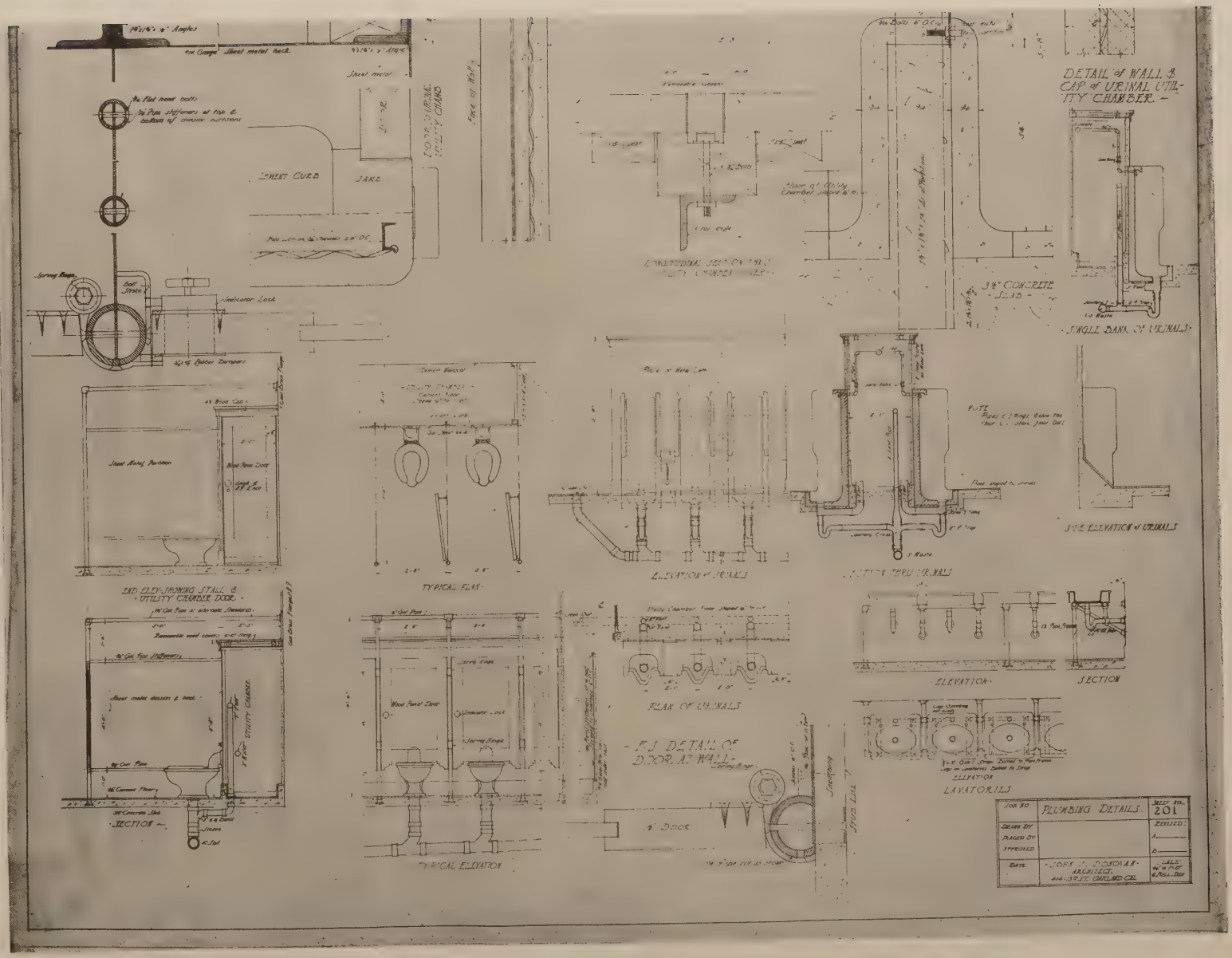

DETAIL of WALL & CAP of URINAL UTILITY CHAMBER.
SINGLE BANK OF URINALS
SIDE ELEVATION of URINALS
ELEVATION of URINALS
SECTION THRU URINALS
TYPICAL PLAN
TYPICAL ELEVATION
PLAN OF URINALS
F.S. DETAIL OF DOOR AT WALL
ELEVATION
SECTION
ELEVATION
SECTION
ELEVATION
LAVATORIES
PLUMBING DETAILS.
SHEET NO. 201
REVISED:
JOB NO.
DRAWN BY
TRACED BY
APPROVED
DATE
JOSEPH J. DONOVAN
ARCHITECT
OAKLAND CAL

Fig. 465.

Mr. Floyd A. Naramore, Architect.

FIG. 466. — TOILET ROOMS, FRANKLIN HIGH SCHOOL, PORTLAND, OREGON.

Supply pipes to fixtures and banks of fixtures should be proportioned to supply them adequately without undue pressure drop, and the distribution system ought to have the same care in design as would be exercised in laying out any other kind of piping installation.

For reasons of strength, and on account of smaller sizes fouling easily, three-quarters inch is the least allowable diameter for branches. Every branch should be valved, and a valve should be provided for each group of fixtures exceeding two in number. This will be appreciated in case of accident, or if renewals and repairs are made to the system. In addition to the above, no hot-water pipe should be less than ten inches from cold-water piping. Low pockets should not be permitted unless a drain is installed, and every part of the system should be so arranged that it can be readily drained clear of water.

Hot-water Circulation. — In most buildings a circulating system is a necessity to insure hot water at the fixtures promptly without waste of water. Usually these circulating systems consist of a series of circulating returns brought back to the hot-water tank. There are two things to avoid in installing a circulating hot-water system, — one is a long run of horizontal pipe between the tank and riser, the other is a check valve in the return at the tank; poor or no circulation will be the result from either. The main hot-water riser should be carried up in a location as near the tank as possible, so that the flow will be vigorous.

Fire Protection. — The details of the fire protection system are regulated by law in many cities; but whether this be the case or not, the installation should be installed in such a way as to meet with the approval of the fire department.

Fire protection in most schools is limited to standpipes and fire hose, although some are equipped throughout with automatic sprinklers. The installation of sprinkler systems entails a very heavy expense, and its advisability is open to question in the majority of instances. Among the Portland schools there are but two or three fully equipped. With proper supervision of plant the hazard from internal fire should be very small.

FIG. 467. — CLAWSON ELEMENTARY SCHOOL, OAKLAND, CALIFORNIA. *Mr. John J. Donovan, Architect.*

Statistics show that practically all school fires start in or about the heating plant, and at early hours in the morning during cold weather. This may be due to defective apparatus, or from the janitor's coming on duty late and attempting to heat up in too short a time. Fuel, especially wood, may be carelessly stored too near smoke pipes, and if soft coal, lignite for instance, is the fuel, the fire may result from spontaneous combustion.

Most of the older schools in Portland were frame structures with hot-air furnaces and fuel storage in the basements, in some cases as much as seventy-five to one hundred cords of wood being stored in one building. Having been built before the days of competent fire regulations, many of these plants were anything but good fire risks. In 1916, however, adequate financial provision was made, and all furnace and fuel rooms were thoroughly fireproofed. The ceilings were protected by metal lath and plaster, all unnecessary openings were closed, wood partitions removed and replaced by tile. The doors opening into the space occupied by the heating plant and fuel were metal-covered, and air intakes, wherever they were of inflammable material, were replaced by metal. Finally, the heating and fuel spaces were equipped with automatic sprinklers, as were various out-of-the-way closets, storerooms, and in most instances the domestic science and manual training rooms. Each installation was provided with a regulation automatic alarm valve and bell on the outside of the building.

Such installations go far to promote immunity from fire, contribute much to the safety of the occupants, and reduce the cost of insurance.

Standpipes and Fire Hose. — Standpipes and fire hose should be installed so that any portion of the building can be reached by a length of hose not exceeding seventy-five feet. Hose should be provided in attic spaces and should be so located as to be readily accessible.

The hose outlet should be full size, two and one-half inch, with standard fire department thread. One and one-half inch unlined linen hose in lengths of not over seventy-five feet, and racks which allow the hose to hang in loops are better than reels for holding the hose. Racks with a rated capacity of twenty-five feet more than the actual length should be employed, as this does not crowd the hose so much and there is less liability of its coming loose. It is understood of course that each hose outfit

requires a hose reducer if small hose is used, and in addition, a spanner and two extra hose gaskets should be secured to each rack.

Pipe Covering. — Some form of non-conducting covering is required on hot-water piping. It is usually asbestos or magnesia. The cold-water should be covered with felt covering to prevent the drip of condensation and reduce liability of freezing. In some localities subject to very low extremes of temperature, covering is also extended to include roof conductors in cold attics and to portions of the drainage piping.

Plumbing Fixtures. — Plumbing fixtures should be selected with all due regard to the school and to their particular uses within the school. It might not be out of place to state here that range closets and range urinals have no place in any building making any pretense to sanitation. They are prohibited by law in most cities and should be in all.

No attempt will be made here to state what the best types of fixtures are, but briefly what is customary in the Portland school district.

Water closets are siphon-jet, and if installed in main toilet rooms, they are provided with raised rear vents and fan exhaust ventilation — for boys' toilets extended lip, girls' toilets raised front.

Seat-action closets are used in all elementary schools. This is open to discussion. The opponents claim, among other things, that seat-action, self-flushing closets, tend to make the children careless at home and elsewhere.

Up to 1916, many flushometer valves had been installed, but few came up to anything like expectations. The combination giving the best satisfaction is a high vitreous tank with or without seat-action feature.

For elementary schools 13-inch bowls are specified, weighing not less then fifty-five pounds each. For high schools and trade schools, 14-inch bowls, 60 pounds.

Buff ware vented stall urinals, 18″ wide and set 24″ on centers with one five-gallon vitreous flushing cistern for each four urinals. The tanks are furnished with automatic flushing mechanisms, and a separate stop is placed hand high from the floor.

Vitreous lavatories are used, and are provided with self-closing stops of the very best quality.

Porcelain slop sinks, one on each floor, with hose bibb on the cold-water side.

No porcelain enameled ware is used, excepting in sinks, which always are provided with roll rims and with back.

CHAPTER XXVII

ELECTRICAL INSTALLATION AND ILLUMINATION

By Romaine W. Myers, *Consulting Electrical Engineer*

Kind of Electric Service. Electric Lighting of Assembly Halls. Electricity for the Different Departments. Science Department Service. Switchboards and Panel Boards. Clock and Program Systems. The Telephone System. Lighting of Schools. (1) General Consideration. Specific Recommendations. (1) Natural Lighting. (2) Artificial Lighting. (3) Examples of Classroom Lighting.

Code of Lighting School Buildings by Illuminating Engineering Society. Preface. General Requirements. Intensity of Artificial Illumination. Shading of Lamps. Distribution of Light on the Work. Color and Finish of the Interior. Switching and Controlling Apparatus. Emergency Lighting. Inspection and Maintenance.

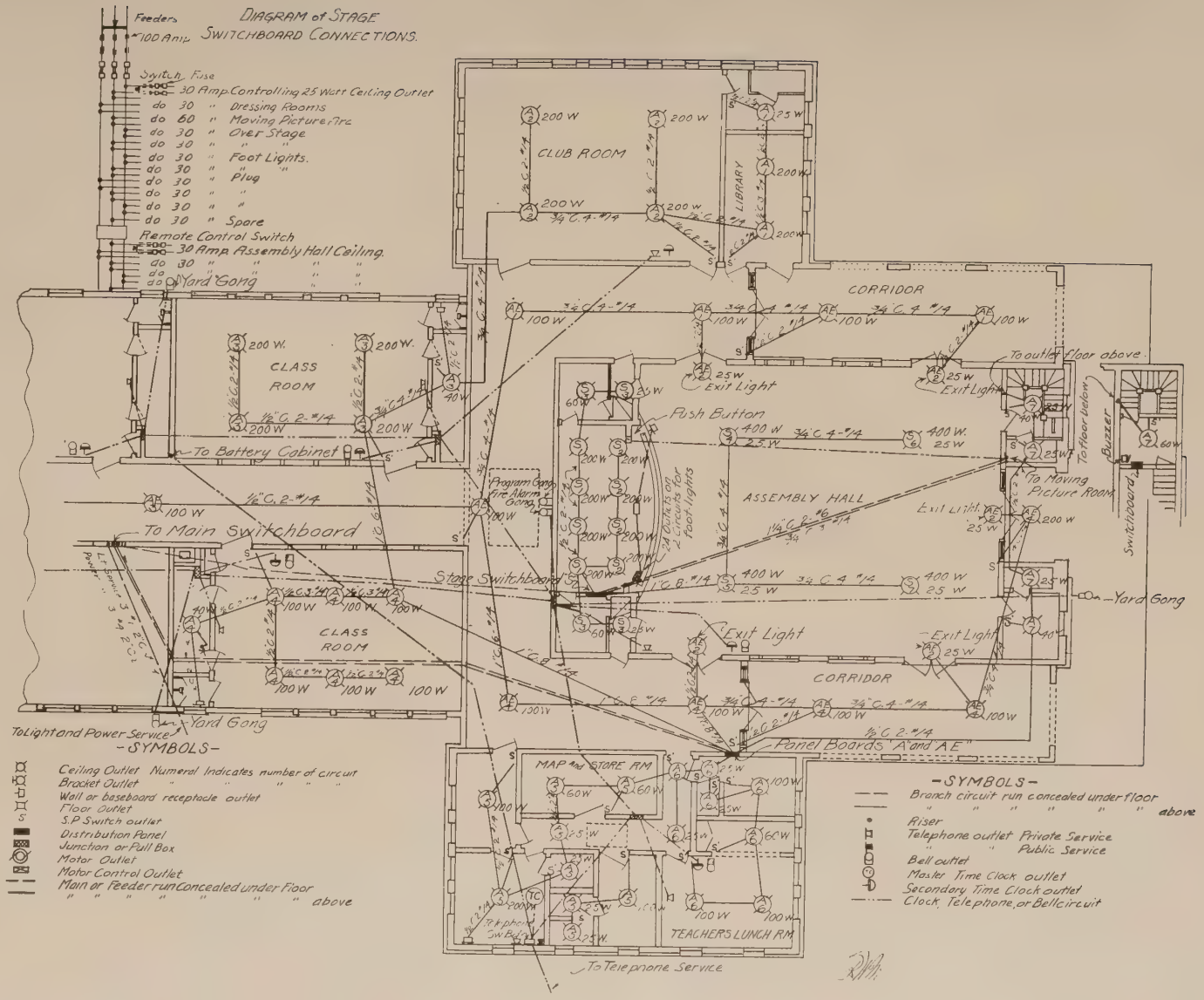
Daylight: Intensity of Daylight. Direction of Light. Window Openings. Lighting Value of a Window. Window Shades. Light Courts. Maintenance.

Artificial Light: Systems of Lighting. (1) a Direct Lighting System; (2) a Semi-indirect System; (3) an Indirect System. Shading of Lamps. Glossy Surfaces and Eye-strain. Color of Light. Design of Lighting Installation. Blackboards. Rehabilitating the Lighting of Old Buildings. Maintenance.

Kind of Electric Service. — In planning the electrical installation for a school, the first requirement necessary after a study of the proposed building and local regulations, is to decide upon the system, that is, whether to use alternating or direct current and the voltage. As a rule the choice is limited by the service available from the power company. When choice is not thus limited it is of prime importance that a decision be made at once. Very often the power and light are taken from the same service. Where a separate power service is not obtainable, it is advantageous to install separate transformers, one set for light and one set for power. This installation will eliminate to a great extent any fluctuations of voltage that would otherwise exist in lamps if the lighting load were on the same transformers as the motors.

The services to a school building should preferably enter underground and run direct to a main switchboard located in a switchboard room. This room should be locked and only authorized persons should be allowed to enter. The size of the services will, of course, depend upon the number of lights and motors that may be in the building. To obtain this estimate, it is necessary to make a complete layout of the proposed installation A typical plan for a grade school is herewith shown in Figure 468. First, the outlets are carefully spaced to give a uniform illumination, the wattage being obtained by calculation. The next step is to circuit these outlets, placing no more on a circuit than are permitted by the National Board of Fire Underwriters or by the local rules and regulations. The wiring should all be placed in conduit, the sizes of conduit and wire therein should be shown on the plan for each run. The circuit runs terminate in stage switchboards or panel boards. Figure 469 shows a typical panel board of a safety type, which is strongly recommended for all school work. All corridor and exit lights should be connected to a separate section in the panel board. They should be fed by direct feeders from the main switchboard and connected for emergency lighting to another meter located ahead of the regular one. Where separate service is available it is recommended that the emergency lighting be connected to it. All circuit runs should be carefully calculated for size of copper. The voltage drop should not exceed 2 per cent.

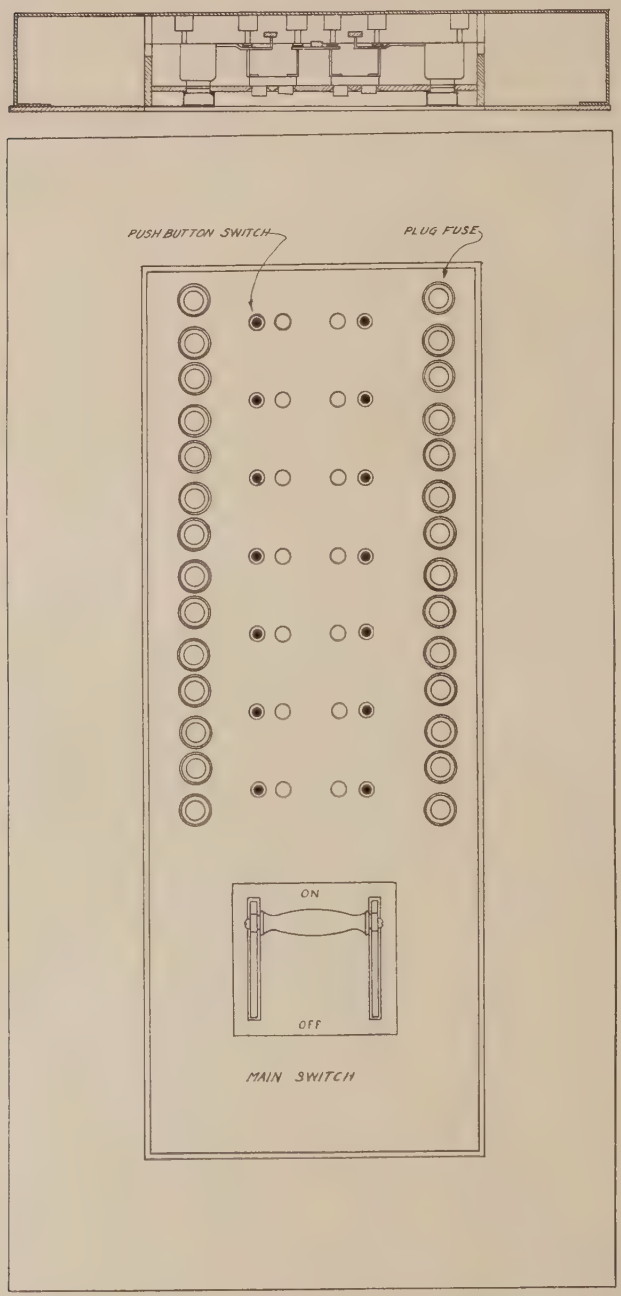
Electric Lighting of Assembly Halls. — The assembly hall and stage lighting should be controlled from the stage switchboard. Figure 469 shows diagram of connections for a grade-school stage switchboard. In Figure 470 is shown a diagram of connections for a high-school stage switchboard. A front view of this board is shown in Figure 471, the switches being all of the dead front safety type. A safety switch is recommended for all switches and switchboards that are not locked and under the exclusive supervision of one versed in electrical work. Industrial accident commissions in several states require a switch of this character. A detail of the safety switch used in switchboard (Figure 471) is shown in Figure 472. This switch has an iron handle similar to that of an oil switch, the exterior face being of sheet metal. On the lower portion of this face is a door, through which admission to the fuses may be obtained



TYPICAL PLAN OF ELECTRIC WORK FOR A GRADE SCHOOL.

SCALE:— 0 8 16 24

FIG. 468.



TYPICAL SAFETY PANEL-BOARD.

Fig. 469.

when switch is not in contact. The switch cannot be closed without closing the fuse door. Thus there are exposed no live parts whereby anyone could possibly receive a shock. In Figures 470 and 471, No. 1 is the grand master (400 amp. T. P. switch); No. 2 is the stage main (400 amp. T. P. switch); No. 3 is the main for the assembly-hall lights (100 amp. T. P. switch); No. 4 is the remote control switch (100 amp. T. P. switch) operated from push button No. 21 and from the moving picture operator's room; No. 5 is the assembly-hall individual circuit switches; No. 6 is the white-light master (100 amp. T. P.); No. 7 are the white footlights, first, second, and third border lights through dimmers No. 16; No. 8 is the red-light master (60 amp. T. P.); No. 9 are the red footlights, first, second, and third red border lights through dimmers No. 15; No. 10 is the blue master (60 amp. T. P.); No. 11 are the blue footlights, first, second, and third blue border lights through dimmers No. 17; No. 12 is the A. C. pocket master (100 amp. T. P.); No. 13 are the D. P. switches to pockets through dimmers No. 20; No. 14 are D. P. switches for operation of lights in assembly-hall lights ahead of remote control switch No. 4; No. 18 is the direct current master (100 amp. D. P.) which controls switches No. 19 pockets on stage. At the ends of the above board grill doors made of iron wire ($\frac{1}{2}''$) mesh should be provided.

Direct current is generally obtained, when not otherwise available, by the installation of a motor generator set placed in the physics laboratory.

In any school with a stage of sufficient size for the production of plays it is essential that an equipment as outlined above be included.

It is recommended when purchasing a motion-picture projection machine that one be obtained that is equipped with an incandescent lamp for motion-picture projection service, as this is an improvement over the regular arc lamp type. Its simplicity and ease of operation commends it for school work. In providing for a motion-picture projection machine it is necessary to make provision for sufficient size feeds to the machine.

Electricity for the Different Departments. — In a great many cities, cooking is now being done exclusively by electricity; this method is rapidly on the increase. In building a school, the domestic science department should be supplied with copper feeds of sufficient size to take care of several complete electric ranges and enough individual electric plates or combination cookers to supply the class. The feeds should run to a central panel located in the department, and from this panel individual circuits can be run to each operator; each circuit should be controlled by an approved indicating switch, preferably the bull's-eye type.

The domestic arts department should be provided with a separate panel from which separate circuits can be run to electric irons, mangles, sewing machines and washing machines.

Science Department Service. — The science department should be equipped with a special switchboard so that current of various voltages and character can be transmitted at will to the laboratory tables and lecture rooms. A switchboard providing these functions is shown in Figure 473. The diagram of connections which are self-explanatory is shown in Figure 474. The

CONNECTIONS FOR STAGE SWITCHBOARD SHOWN IN FIG.-

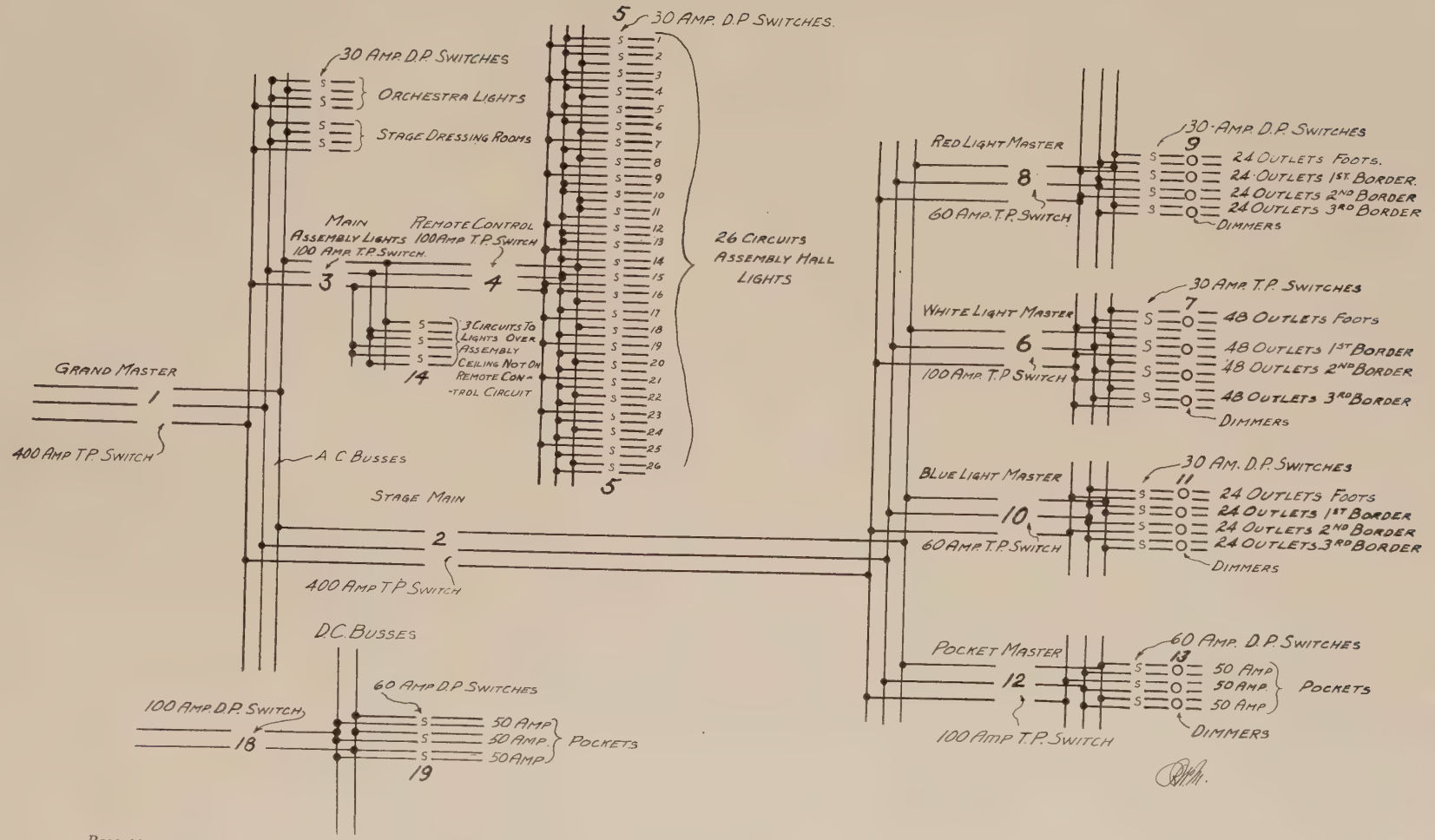


FIG. 470.

direct current is provided from an outside source or from a motor generator. The low voltage is provided by a special multi-voltage motor generator.

Current should be transmitted to each department in the manual training shops by separate feeders from the main switchboard to a safety panel in each department. It is recommended that all motors be individual drive, as this has proven the best type. Each motor should be on a separate circuit and should be furnished with a safety starter equipped with overload and no voltage release. Motors for all ventilating fans, etc., throughout should be controlled and equipped with a similar starter.

Switchboards and Panel Boards. — All panel-board and motor feeders should run to the main switchboard, which is divided into two parts, power and light. The switchboard should be placed in a room designed exclusively for it and should be under the supervision of a competent authorized person. Figure 475 shows a front view of a main switchboard for a large high school. It is advisable to install a graphic wattmeter on the

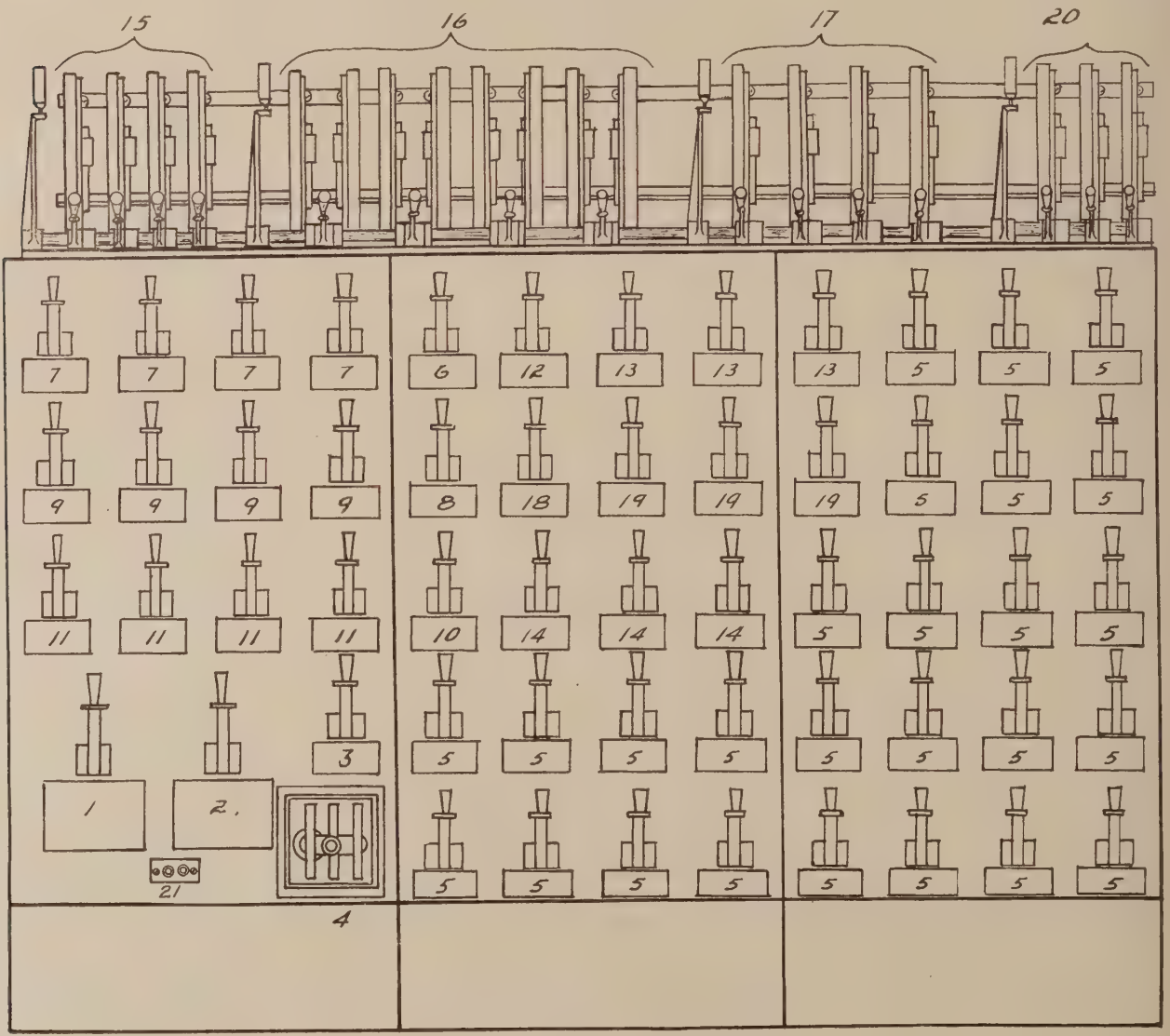
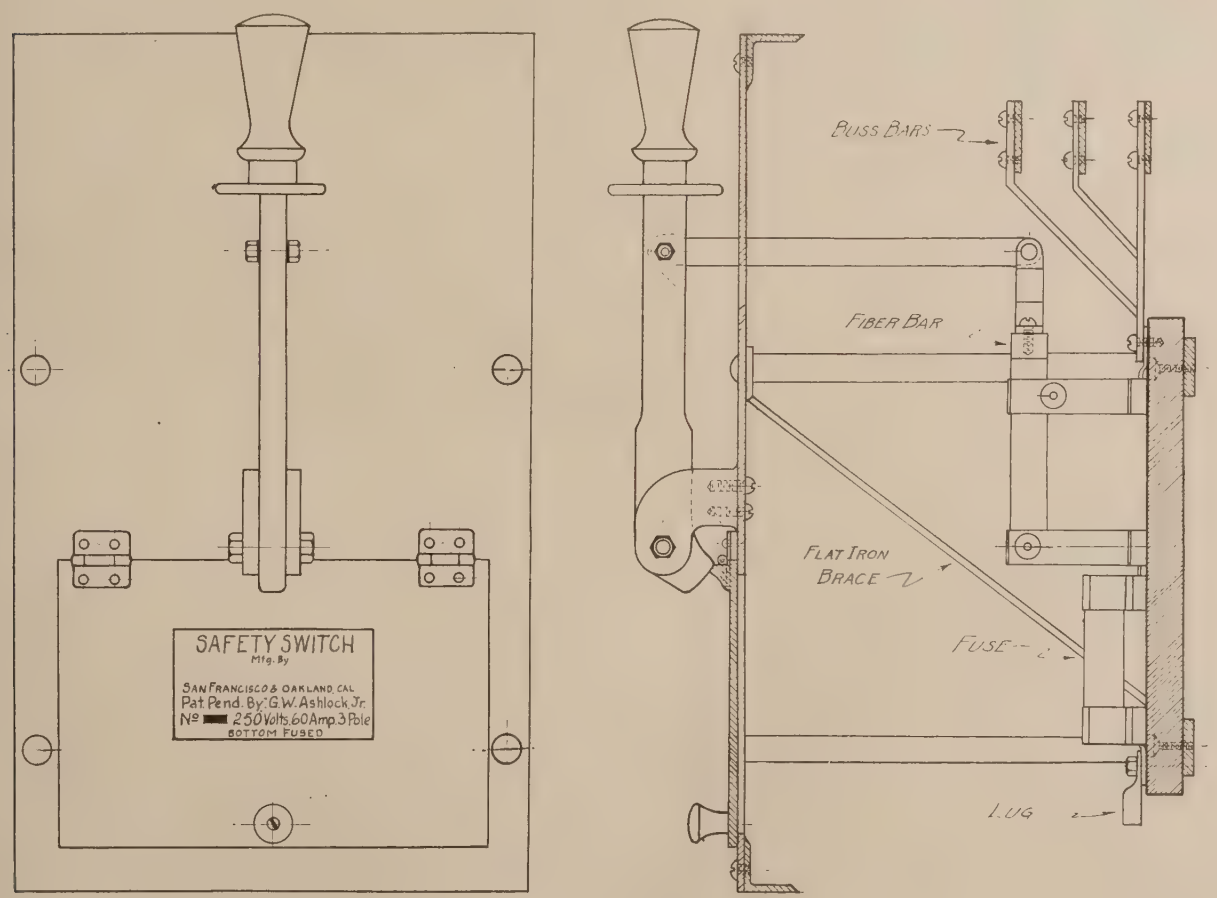


FIG. 471.

lighting load and one also on the power, as these will give on paper a daily record of the current consumed, thereby acting as a check on the consumption of current for any given time.

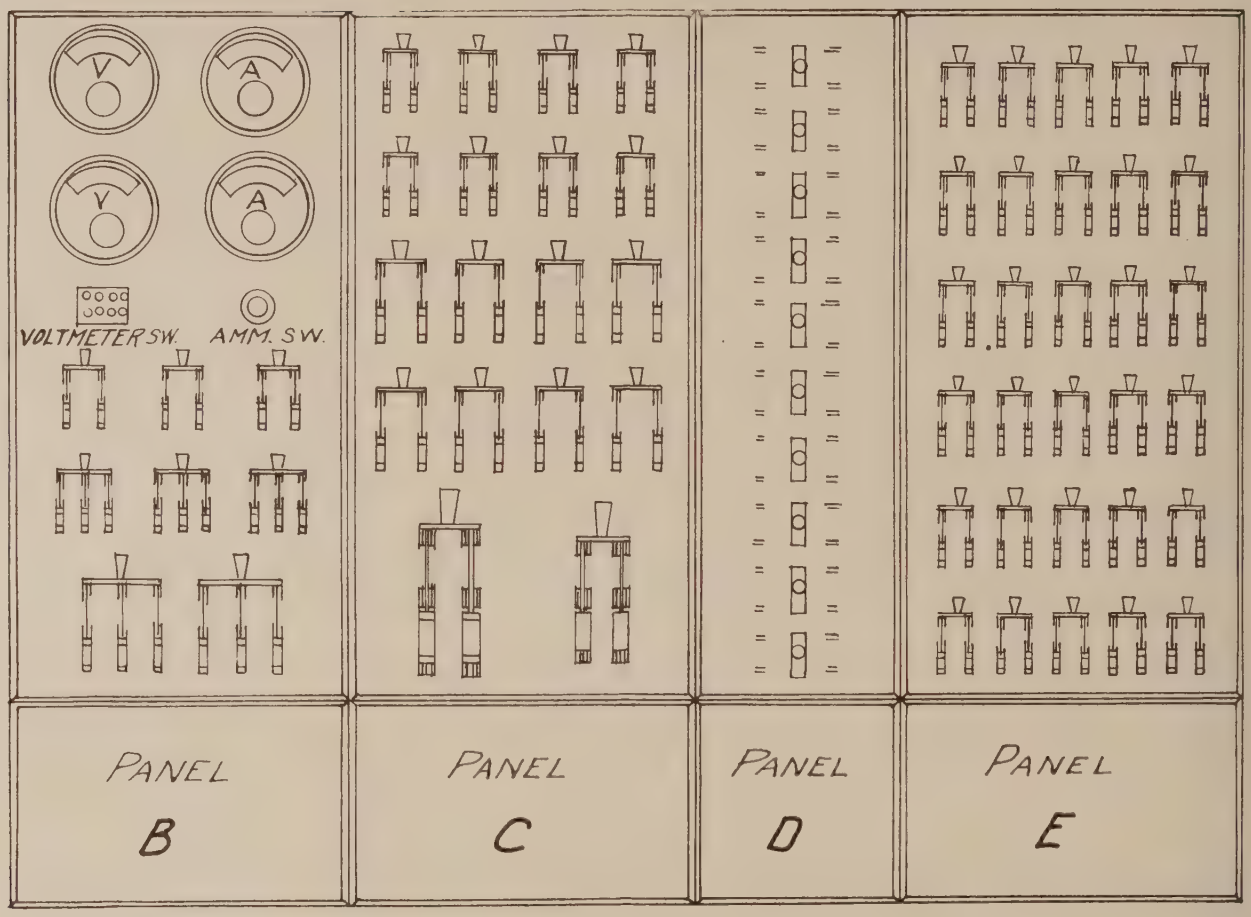
Clock and Program Systems. — In any building or group of buildings where two or more clocks are used, the importance of having all clocks exactly alike cannot be overestimated. There is nothing more annoying than to find a difference of several minutes between two clocks, possibly in adjoining rooms; and the only way to avoid such confusion is to install a high-grade, accurate master electric clock, carefully regulated, and then from it to control electrically all the other clocks. There are two kinds of secondary clocks: first, those operated by an ordinary clock movement and synchronized once an hour by the master clock; second, electric dials, which are operated directly by the master clock. These are sometimes called minute jumpers, on account of the fact that the hands are moved once a minute only, instead of continuously as in an ordinary clock. Where the secondary clocks will not be subjected to much vibration, a synchronized system is usually preferred, but under difficult operating conditions the minute jumpers will give better service, as they have no springs or gears which might be injured by vibration.

The electric program clock has become an essential feature of the equipment of the modern school. In a school building with numerous classrooms, it is no longer practicable to ring the signals by hand, for in many cases the classes are held at different periods, requiring a complex schedule of signals. The possibilities of a program clock will be readily appreciated when, by means of such a system, signals may be operated at any stated hour, day or night, on one or more different schedules, which may be automatically changed each day of the week, if necessary. Figure 476 shows a diagram of master clock, secondary clocks, program clock, program bells, yard gong, storage batteries, etc. Refer to Figure 468 as to their location in a layout of a school.



SAFETY SWITCH FOR SWITCHBOARDS

FIG. 472.



LABORATORY SWITCHBOARD

SCALE :— 0 1 2

FIG. 473.

The master and program clock is usually placed in the principal's office.

A fire-alarm system should be installed in all schools and buildings. This usually consists of break-glass stations placed in the corridors as noted in Figure 468. From each break-glass station wires are run to an annunciator placed in the principal's office. If the glass is broken at the station the annunciator drop will operate and indicate from what point the alarm is turned in. For periodical testing the stations should be designed to permit operation by a key. Such testing should be done frequently.

The Telephone System. — A telephone system should be installed in all schools. For large schools such as high schools, where a secretary is employed, it is recommended that a regular private exchange system be installed with telephones for each teacher. Such telephones should be of desk type if the teacher is provided with a separate room for an office.

It is not customary or necessary to connect this exchange to outside service, as considerable expense can be eliminated by not doing so. The principal usually has in addition to his school telephone another telephone with connection to the regular telephone company. For grade schools it is recommended that a telephone cabinet of a type that can be placed on the principal's desk be installed ($15'' \times 6'' \times 3''$). The cabinet should be of the key-switching type with the necessary number of line equipments consisting of a visual signal with associated ringing and listening keys, also with a general call button by which all outlying stations may be called simultaneously. A night-bell signal should also be provided. This equipment is wired so that upon removing the receiver from the outlying station, the visual signal

associated with that station will show and night-bell signal operate. To answer the station call, the listening key on the cabinet board is thrown into listening position. The visual signal remains as long as the receiver of the outlying station is off the hook. In calling any or several stations, the respective keys are first thrown to the ringing position and then to the answering or listening position. Except when the general call button is used, keys then need only be thrown to the listening

General Consideration. — The lighting of a school building should be referred to a competent expert before the plans for the building are drawn. The importance of doing this early is evidenced by the fact that the orientation of the building plays an important part in the design of those features which depend upon proper lighting for their effectiveness.

Minimum intensity of illumination, 3.0 to 4.0 foot-candles on the plane of the desk top.

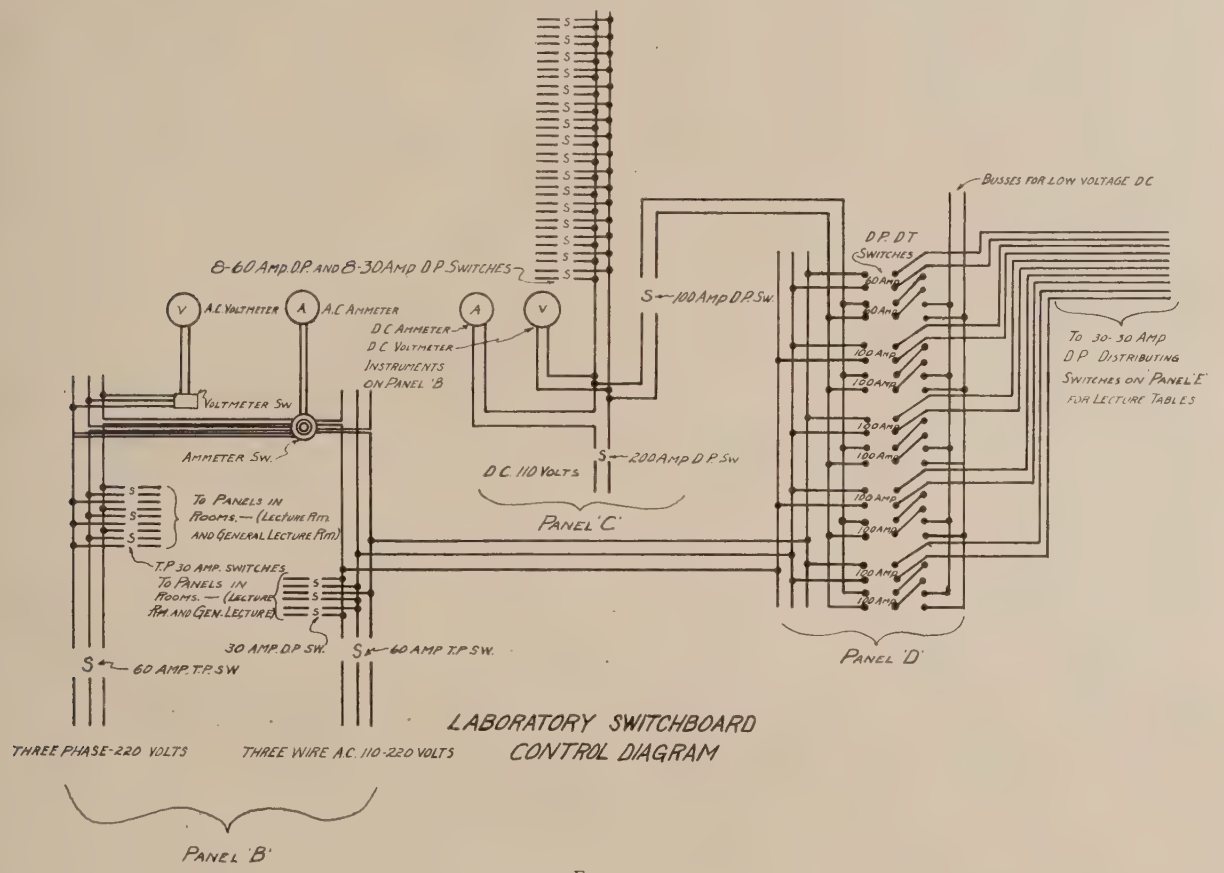

8-60 Amp. D.P. and 8-30 Amp. D.P. Switches
A.C. Voltmeter
A.C. Ammeter
D.C. Ammeter
D.C. Voltmeter
Instruments on Panel 'B'
Voltmeter Sw.
Ammeter Sw.
100 Amp D.P. Sw.
200 Amp D.P. Sw.
D.C. 110 Volts
Panel 'C'
Busses for low voltage D.C.
D.P.D.T. Switches
To 30-30 Amp D.P. Distributing Switches on Panel 'E' for Lecture Tables
To Panels in Rooms. — (Lecture Rm. and General Lecture Rm.)
T.P. 30 Amp. Switches To Panels in Rooms. — (Lecture Rm. and Gen. Lecture)
30 Amp. D.P. Sw.
60 Amp. T.P. Sw.
60 Amp. T.P. Sw.
Panel 'D'
Laboratory Switchboard Control Diagram
Three Phase-220 Volts
Three Wire A.C. 110-220 Volts
Panel 'B'

Fig. 474.

position. The wiring between the cabinet and the outlying stations consists of three wires, one common and two individual. This telephone system requires minimum number of batteries. Classroom telephones should be of the heavy fool-proof type, with receiver connected to the instrument by short flexible steel cable.

Before acceptance is made all apparatus and wiring connected with the school should receive a careful inspection and test by a competent engineer.

Lighting of Schools. — The following brief résumé of requirements in school lighting was presented to the Committee on Lighting Legislation of the Illuminating Engineering Society for use as a basis in formulating a code on school lighting.

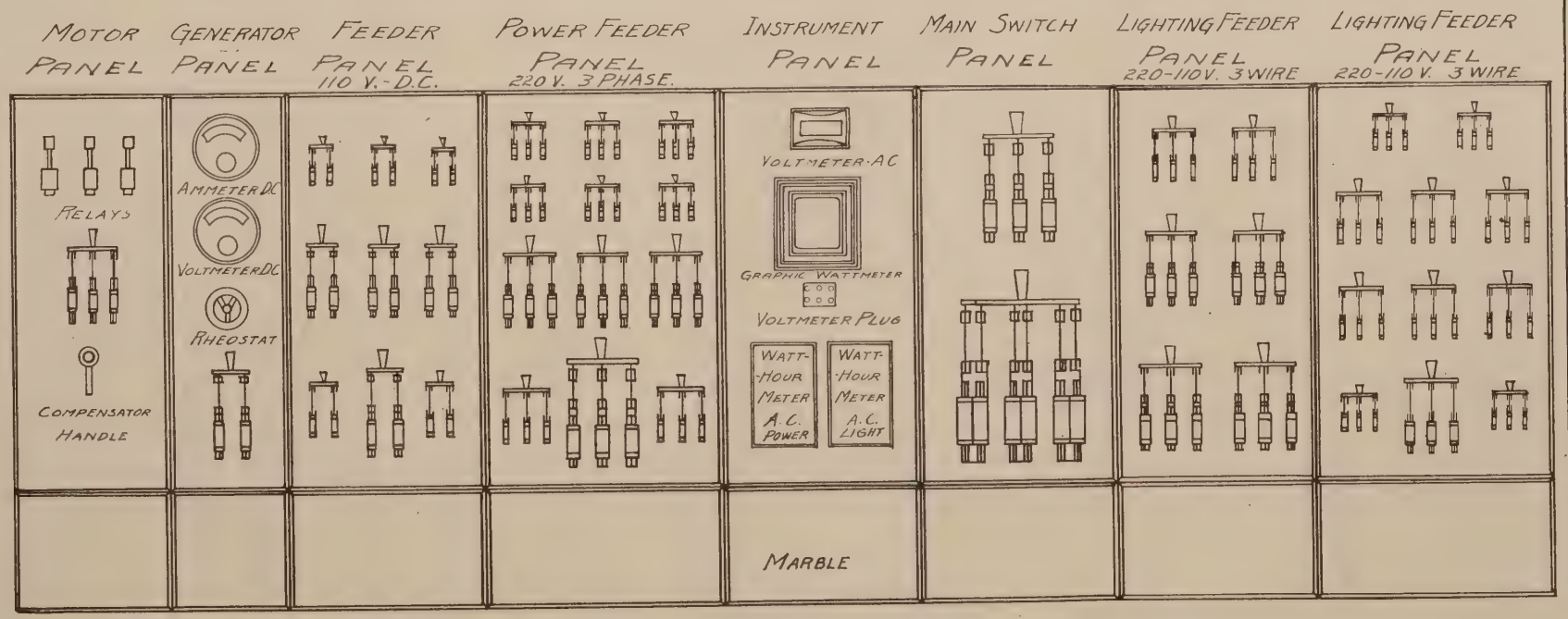
Polished surfaces such as blackboards, glossy paper, polished desk tops, and glazed walls should be avoided.

Light sources (sky or artificial) should be well out of the ordinary visual field.

Glare from blackboards should be avoided. This can be done by carefully placing them, by lighting them artificially, by tilting them, and by having the surfaces of a matte finish. They should never be placed between windows.

Excessively bright contrasts should be avoided. A bright source should not be viewed against a dark background. The walls adjacent to a blackboard should not be too light in color.

Surroundings such as walls and ceiling should be, in



MAIN SWITCHBOARD FOR A LARGE HIGH SCHOOL.

FIG. 475.

general, light in color. Ceilings and frieze should be practically white (high reflecting power). Walls should be reasonably lighted. Colors used should be white, gray, or tints of buff, cream, or olive green.

Children should be taught how to safeguard their vision, that is, how to hold their books, to assume a correct position relative to the light source, to complain of glare from blackboards, etc.

Teachers should be instructed to teach these fundamentals to children.

Good lighting should be incorporated in every course where practicable, especially in the "home-making course."

More Specific Recommendations. *Natural Lighting.* — The glass area should be ample, that is, an appreciable percentage, say at least twenty per cent (20%) of the floor area.

The windows should preferably be located on one side of the room, to the left of the student.

A portion of the sky should be visible from every desk top, at least 5 degrees vertically.

The width of the room should not be more than twice the window height from the floor.

The windows should be equipped with approved window shades for controlling the light and excluding direct sunlight.

Prism glass should be used in extreme conditions.

Lighting and ventilating courts should be painted white.

Minimum illumination on desk top, 3 to 4 foot-candles.

Diversity of illumination not greater than 100 to 1.

Artificial Lighting. — Ample general lighting is recommended. Local units subject to control of pupils are condemned.

Minimum illumination on desk top, 3 to 4 foot-candles.

Light sources should be out of normal visual field if possible.

Light sources should be equipped with diffusing glassware to reduce their brightness and screen the source from the pupil's eyes.

Highest permissible brightness, 3 candle power per square inch when viewed against a light background.

Blackboards should be lighted by properly screened and judiciously placed local units.

The system of lighting will depend upon many conditions; any well-designed system is satisfactory in its proper place. There appears to be a growing tendency for the semi-indirect system. It appears more generally satisfactory for classrooms, reading rooms, etc. In the shops a direct system is advisable.

No local units should be used unless absolutely necessary.

Examples of Classroom Lighting, etc. — Assuming the usual classroom is $24' \times 32'$, Figure 477 shows a lighting layout with semi-indirect units. Four lighting units are supplied, which is the minimum number desirable. Each consists of a heavy density inverted bowl or reflector with 200-watt type C lamp. The top of the glass should be not less than 3 feet from the ceiling in rooms having ceiling height of 11 to 14 feet. Light color walls and light color ceiling was assumed in the above example, using 0.25 as the coefficient of utilization.

Good results may be obtained with direct lighting. Although the diffusion is not so good as with well-designed semi-indirect, a considerable degree is obtained with a white ceiling, and the lack of complete diffusion is compensated for by so placing light units that the light is received on each desk from the best direction. Figure 478 shows a lighting layout with direct units. Six lighting units are supplied. Each consists of a symmetrical prismatic reflector with 150-watt type C bowl frosted lamp. The reflectors are mounted on ceiling flanges fastened to the ceiling. Light color walls and light color ceiling was assumed in the above example, using 0.40 as the coefficient of utilization. If walls and ceilings are darker, larger size lamps will, of course, be necessary.

Auditoriums and assembly halls cannot be lighted according to definite rules, as conditions vary and the decorative side of the problem is important. Efficiency in this case is not important, although reasonable uniformity should be obtained. Glare in any form should be carefully avoided, and the soft effect obtained by semi-indirect or indirect lighting is recommended. For low ceilings, for instance under the balcony, bowls or globes of heavy density glass giving a low transmission of light are advocated, thus insuring a low brilliancy of surfaces in the ordinary range of vision.

The stage of auditorium and assembly halls should be provided with footlights and overhead lights of sufficient quantity to give at least 20 foot-candles on the subject. In the larger auditoriums (high schools) provisions should be made for footlights, border lights, side lights, flood lights, and spot lights. These should be connected with dimmers so that gradation in intensity can be easily obtained.

CODE OF LIGHTING SCHOOL BUILDINGS[1]

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Illuminating Engineering Society
29 West 39th Street, New York City

PREFACE

There are 23,000,000 school children in the United States who are devoting several hours each day to study

[1] Permission to use granted to the writer and the cuts furnished by the Illuminating Engineering Society.

or to the performance of other work equally trying to the eyes. According to the available statistics, nearly 10 per cent of the number of school children examined are found to have defective vision.

The severe requirements imposed upon children's eyes by modern educational methods create need for the best of working conditions. Among these conditions lighting is of first importance. Improper lighting causes eye-strain, resulting in functional disorders, near-sightedness and other defects of the eyes.

The following Code of Lighting School Buildings has been prepared by committees of the Illuminating Engineering Society in order to make available authoritative information for legislative bodies, school boards, and others who are interested in enactments, rules and regulations for better lighting.

The requirements of the code as set forth in the Articles are based upon good practice at the present time. Standards of illumination and other requirements are subject to revision by the Society with advances in the art of lighting.

While the code is intended primarily as an aid in formulating legislation relating to the lighting of school buildings, it is also intended for school authorities as a guide in individual efforts to improve lighting conditions.

Acknowledgment is made of the valuable coöperation of many members and non-members of the Society in the preparation of this code.

Further information on this subject may be obtained by addressing the Illuminating Engineering Society, 29 West 39th Street, New York, N. Y.

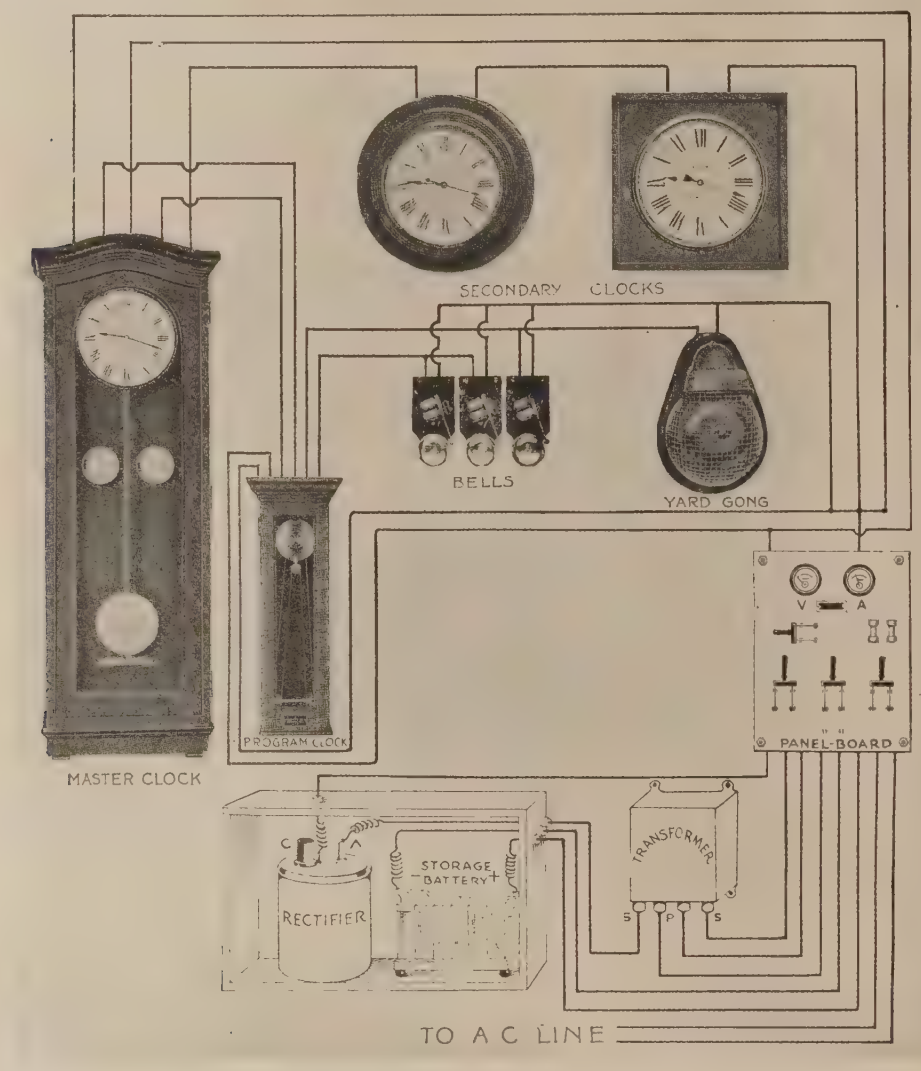


Fig. 476.

Article I. General Requirements. — When in use, all buildings should be provided, during those hours when daylight is inadequate, with artificial light according to the following Articles.

Buildings hereafter constructed should be so designed that the daylight in the work space is reasonably uniform and the darkest part of any work space is adequately illuminated under normal exterior daylight conditions.[1]

Article II. Intensity of Artificial Illumination. — The desirable illumination to be provided and the minimum to be maintained are given in the following table:[2]

[1] Daylight illumination values should be at least twice the values given in the Table, Article II, for artificial lighting.

[2] The illumination intensity should be measured on the important plane, which may be the desk-top, blackboard, etc.

The method of computing the flux of light (lumens) required to do any desired illumination is described under the heading "Design of Lighting Installation" on page 565.

For more specific information regarding the lighting of shops, see "*Code of Lighting Factories, Mills and Other Work Places*," issued by the Illuminating Engineering Society.

DESIRABLE AND MINIMUM ILLUMINATION

	ARTIFICIAL LIGHTING FOOT-CANDLES (LUMENS PER SQUARE FOOT)[1] AT THE WORK	
	Minimum	Ordinary Practice[2]
Storage spaces	0.25	0.5– 1.0
Stairways, corridors	0.5	1.0– 2.5
Gymnasiums	1.0	2.0– 5.0
Rough shop work	1.25	2.0– 4.0
Auditoriums, assembly rooms	1.5	2.5– 4.0
Classrooms, study rooms, libraries, laboratories, blackboards	3.0	3.5– 6.0
Fine shop work	3.5	4.0– 8.0
Sewing, drafting rooms	5.0	6.0–12.0

Article III. Shading of Lamps. — Lamps should be suitably shaded to minimize glare. Glare, either from lamps or from unduly bright reflecting surfaces, produces eye-strain.

Article IV. Distribution of Light on the Work. — Lamps should be so arranged as to secure a good distribution of light on the work, avoiding objectionable shadows and sharp contrasts of intensities.

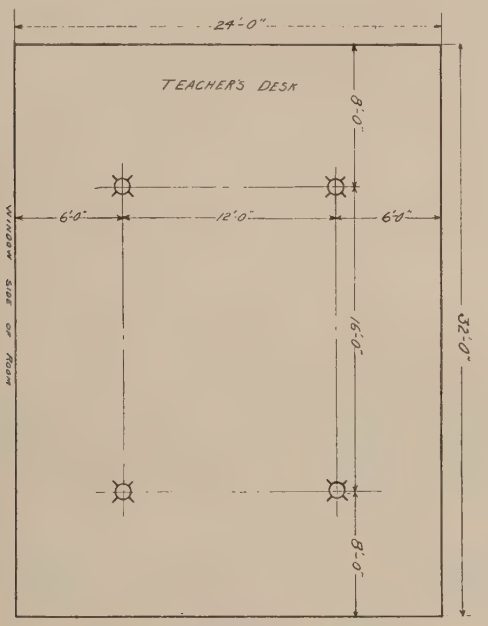


FIG. 477.

Article V. Color and Finish of Interior. — Walls should have a moderate reflection factor; the preferred colors are light gray, light buff, dark cream and light olive green. Ceilings and friezes should have a high reflection factor; the preferred colors are white and light cream. Walls, desk-tops and other woodwork should have a dull finish.

Article VI. Switching and Controlling Apparatus. — Basements, stairways, storerooms, and other parts of the building where required, should have switches or controlling apparatus at point of entrance.

Article VII. Emergency Lighting. — Emergency lighting should be provided at main stairways and exits to insure reliable operation when, through accident or other cause, the regular lighting is extinguished.

Article VIII. Inspection and Maintenance. — All parts of the lighting system should be properly maintained to prevent deterioration due to dirt accumulation, burned-out lamps and other causes. To insure proper maintenance, frequent inspection should be made at regular intervals.

NOTES — DATA AND RECOMMENDATIONS

DAYLIGHT

Intensity of Daylight. — In general, the minimum intensities of daylight illumination should be considerably greater than those provided in artificial lighting, owing to the adaptation of the eye to a much higher level of illumination (brightness) in the daytime.

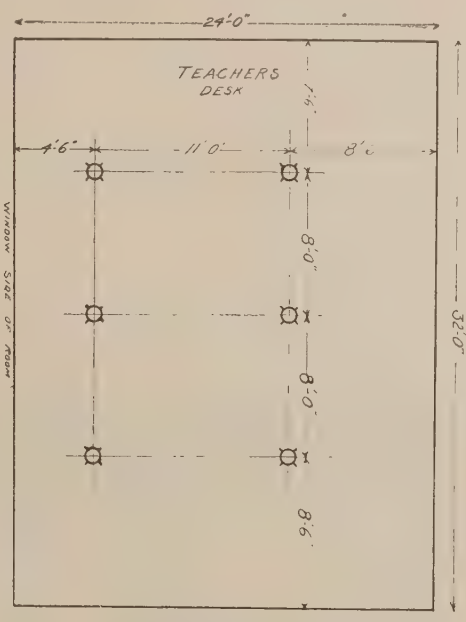


FIG. 478.

Direction of Light. — One of the fundamental rules for proper lighting of desks is to have the preponderance of light come from the left side. For this reason many school authorities advocate *unilateral* lighting, that is, lighting by windows located on one side of the room only, especially for classrooms. (See Figure 479.) This method

[1] It should be borne in mind that intensity of illumination is only one of the factors on which good seeing depends.

[2] Under the column headed "Ordinary practice," the upper portion of the range of intensities is preferable to the lower; where economy does not prohibit, even higher intensities than those cited are often desirable.

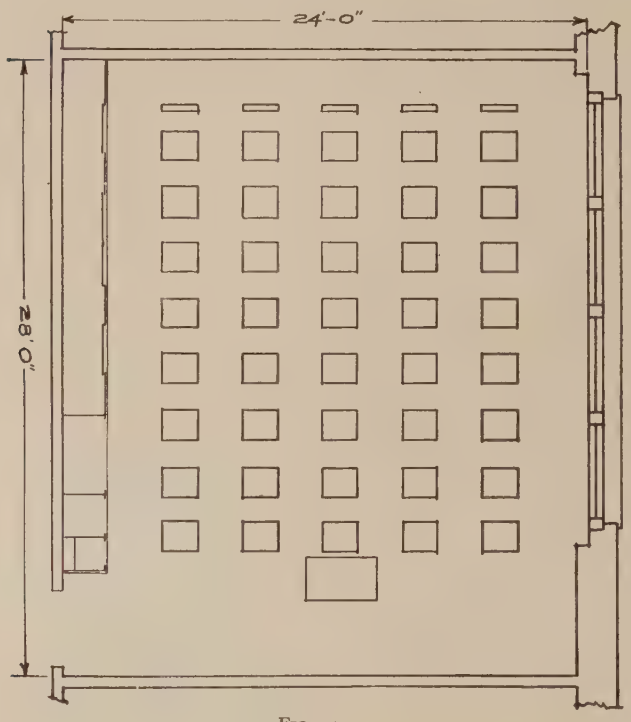


FIG. 479.

of lighting is recommended where the rooms do not exceed about 24 feet (7.9 m.) in width, with windows about 12 feet (3.9 m.) high. If the rooms are much wider than this, *bilateral* lighting, that is, lighting by windows located on two sides of the room, may be required in order to provide sufficient illumination in every part of the room and at the same time to prevent too great a diversity of contrast in the intensity of light on the work spaces.

To secure the highest lighting value it is recommended that the room be so designed that no working location is more distant from a window than one and one-half times the height of the top of the window from the floor.

Windows at the left and rear where practicable are preferable to those on the left and right sides of the room, because of cross shadows created by the latter arrangement. Lighting by overhead sources of natural illumination, although sometimes used for assembly rooms, auditoriums and libraries, with relatively high ceilings, has ordinarily little application in classrooms and has found little favor in practice.

The sky as seen through a window is a source of glare. For this reason the seating arrangements should always be such that the occupants (pupils) of the room do not face the windows.

Window Openings. — Tests of daylight in well-lighted school buildings indicate that, in general, the glass area does not fall below 20 per cent of the floor area.

As the upper part of the window is more effective in lighting the interior than the lower part, it is recommended that the windows extend as close to the ceiling as practicable.

Lighting Value of a Window. — The lighting value of a window at any given location in the room will depend upon the brightness of the sky, the amount of sky visible through the window at the given location in the room, and indirectly upon the reflection factor of the surroundings and the dimensions of the room.

Observations in well-lighted schoolrooms having a comparatively unobstructed horizon, show that under

FIG. 480.

normal conditions of daylight, satisfactory illumination is usually obtained when the visible sky subtends a minimum vertical angle of 5° at any work point of the room.

In cases in which the horizon is obstructed, as by adjacent high buildings or by high trees, provision should be made for a larger window area than would otherwise be required; also if need be, for redirecting the light into the room by means of prismatic glass in the upper sashes of the windows, or by prismed canopies outside of the windows.

FIG. 481.

Window Shades. — Although direct sunlight is desirable in interiors from a hygienic standpoint, it is often necessary to exclude or diffuse it by means of shades. These shades should perform several functions, namely, the diffusion of direct sunlight, the control of illumination to secure reasonable uniformity, the elimination of glare from the visible sky and the elimination of glare from the blackboards wherever possible. These requirements make it desirable to equip each window, especially in classrooms, with two shades operated by double rollers placed near the level of the meeting rail. The window shades may thus be raised or lowered from the middle, which provides the maximum elasticity for shading and diffusing the light. The shades should be preferably of yellow-colored material that is sufficiently translucent to transmit a considerable percentage of the light while at the same time diffusing it.

A more complete control of the light may be obtained by the use of two independent sets of shades at each window. Where two sets of shades are used, one should be preferably a very dark green of heavy material that will exclude the light entirely, and the other preferably a yellow-colored material as above described.

Different views of a window equipped with a single set of adjustable shades as used in the public schools of New York City are shown in Figure 480. It will be noted that this method of installation permits of lowering the window from the top or raising it from the bottom without interference with the shades.

Light Courts. — Reflection of light from the walls of courts is very helpful in increasing interior illumination. Hence the walls of courts should have high reflection factors. Dark colors should be avoided.

Maintenance. — Windows and overhead sources of natural light (so-called skylights) should be washed at frequent intervals, and surfaces such as ceilings and walls should be cleaned and refinished sufficiently often to insure their efficiency as reflecting surfaces. It should be borne in mind that the maintenance of adequate daylight indoors is also dependent upon various external factors, such as the future erection of buildings and the growth of trees or vines.

FIG. 482.

ARTIFICIAL LIGHT

Systems of Lighting. — It is customary to divide the systems of artificial lighting into three classes, namely, *direct*, *semi-direct*, and *indirect*. This division is arbitrary and the boundary lines are quite indefinite.

A direct lighting system is known as one in which most of the light reaches the work plane directly from the lighting unit including the accessory which may be an opaque or glass reflector or a totally inclosing transparent or translucent envelope. Direct lighting systems may

be further classified as *localized* and *general* or distributing. In the former the units are so placed as to light local work spaces, and in the latter they are well distributed so as to light the whole area more or less uniformly.

A semi-indirect system is known as one in which a portion of the light reaches the work plane directly from the unit and a relatively large portion reaches the work plane indirectly, by reflection from the ceiling and walls. The accessory is usually an inverted diffusing bowl or glass reflector. When this glass has a high transmission factor the lighting effect approaches that of ordinary direct lighting, and when of low transmission, the effect approaches that of indirect lighting.

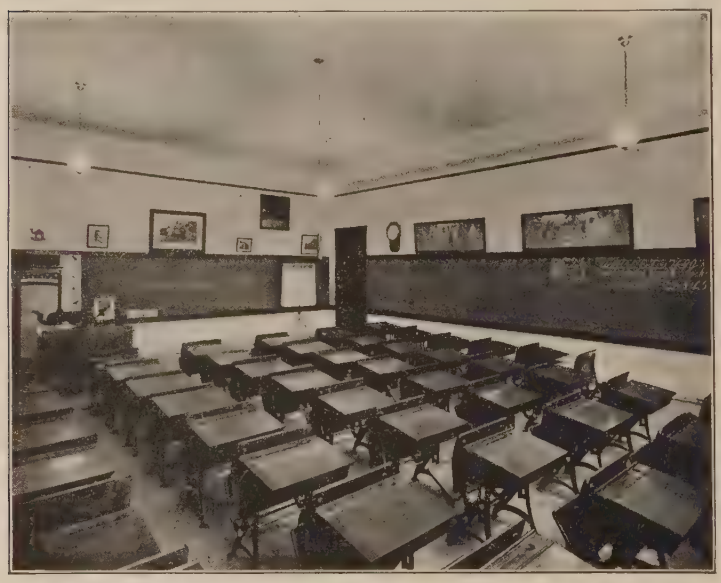


FIG. 483.

An indirect system is known as one in which all or practically all the light reaches the work plane indirectly after reflection from the ceiling and walls. The accessory is usually an opaque or slightly translucent inverted bowl or shade containing a reflecting medium.

All three of these systems of lighting (illustrated in Figures 481, 482, and 483) are in successful use in schools. There has been a growing preference for semi-indirect and indirect lighting, especially since the introduction of modern lamps of great brilliancy. Local lighting by lamps placed close to the work is unsatisfactory except for special cases such as the lighting of blackboards, maps, charts, etc. Examples of bad lighting are shown in Figures 484, 485, and 486.

Shading of Lamps. — Except in very rare instances bare light sources should not be exposed to view. They should always be adequately shaded or completely hidden. Even when shaded by translucent media, such as dense glassware, the lighting units should be placed well out of the ordinary range of vision; in other words it is recommended that lighting units be of low brightness,[1] even if they are located high in the field of view.

The maximum brightness contrast of juxtaposed surfaces in the normal visual field should be preferably not greater than 20 to 1; that is to say, the darkest part of the work space observed should have a brightness preferably not less than one-twentieth of that of the brightest part.

Glossy Surfaces and Eye-strain. — Glossy surfaces of paper, woodwork, desk-tops, walls and blackboards are likely to cause eye-strain because of specular or mirror-like reflection of images of light sources, especially when artificial light is used. Matte or dull finished surfaces are recommended. It is to be noted that a high reflection factor does not necessarily imply a polished or glazed surface.

To minimize eye-strain it is recommended that un-

[1] Preferably not to exceed 250 millilamberts. A millilambert is equal to the brightness of a perfectly reflecting and diffusing surface illuminated to an intensity of 0.929 foot-candle (0.929 lumen per square foot). It is also equal to 0.202 candle per square inch.

The following table shows the order of magnitude of the brightness of some light sources in common use:

	Approximate brightness	
	Millilamberts	Candles per sq. in.
Indirect lighting: ceiling, directly above the lighting unit	5. to 75.	0.01 to 0.15
Semi-indirect lighting: heavy density glassware	35. to 100.	0.07 to 0.2
" " " light density glassware	200. to 1,000.	0.4 to 2.0
Direct lighting: 10 in. (25 cm.) opal glass ball containing 100-watt vacuum tungsten lamp at center	250. to 500.	0.5 to 1.0
" " vacuum tungsten lamp (frosted), in open bottom reflector	2000. to 3000.	4. to 6.
Vacuum tungsten lamp, filament exposed to view	500000.	1000.
Gas-filled tungsten lamp, filament exposed to view	2000000.	4000.
Gas-mantle, bare	15000.	30.
" " concealed in 6 in. (15 cm.) opal glass globe	1000.	2.
Mercury arc tube (glass)	8000.	16.
Daylight: clear blue sky	1000.	2.

glazed paper and large plain type be used in school books.

Children should be taught to hold their books properly, to assume a correct position relative to the light source, and to safeguard their vision.

Color of Light. — It has been found in practice that the admixture of daylight and artificial light is not satisfactory unless the latter is derived from lamps designed with special reference to producing daylight color values. Hence in waning daylight it is desirable to shut out the daylight and to use artificial light exclusively unless the lamps are of the type mentioned.

Design of Lighting Installation. — The illumination intensity on the horizontal work plane should be as uniform as possible. The variation should not be greater than 4 to 1.[1]

FIG. 484.

APPROXIMATE COEFFICIENTS OF UTILIZATION — MODERN LIGHTING EQUIPMENT

	LIGHT COLOR WALLS LIGHT COLOR CEILING	MEDIUM COLOR WALLS LIGHT COLOR CEILING
Small Rooms (offices, corridors, etc.).		
Direct lighting; dense glass (open bottom reflectors)	0.40	0.35
Semi-indirect lighting; dense glass	0.25	0.22
Indirect lighting	0.23	0.20
Medium Sized Rooms (classrooms, Laboratories, etc.).		
Direct lighting; dense glass (open bottom reflectors)	0.50	0.45
Semi-indirect lighting; dense glass	0.35	0.30
Indirect lighting	0.30	0.25
Large Rooms (Auditoriums, etc.).		
Direct lighting; dense glass (open bottom reflectors)	0.62	0.60
Semi-indirect lighting; dense glass	0.43	0.40
Indirect lighting	0.40	0.38

The chief factors which must be considered in arriving at the size and number of lamps to be used in a given room are (1) the floor area; (2) the total luminous flux[2] emitted per lamp, and (3) *coefficient of utilization* of the particular system considered. The first should be measured in square feet. The second may be obtained from a data book supplied by the manufacturers of lamps. The third involves many factors, such as the relative dimensions of the room, the reflection factor of the surroundings, the number of lighting units and their mounting height, and the system of lighting. By *coefficient of utilization* is meant the proportion of the total light flux emitted by the lamps which is effective on the work plane. In the accompanying table approximate coefficients of utilization for modern lighting equipment are given. The work plane in this case is a horizontal plane 30 inches (76 cm.) above the floor. These values refer to the initial installation without any allowance for depreciation.

For determining approximately the size and number of lamps to be used in a given room by means of the coefficients of utilization given in the preceding table, it is necessary to know the luminous output in lumens per watt for the electric lamps considered or in lumens per cubic foot of gas consumed per hour if gas lamps are considered. At the present time (1917) the light output of tungsten filament electric incandescent lamps, based on average service conditions of regularly maintained installations, ranges from 8 lumens per watt for the smaller vacuum tungsten lamps to 14 lumens per watt for the larger gas-filled tungsten lamps employed in school lighting. For incandescent gas systems similar service values range from 150 to 250 lumens per cubic foot of artificial gas consumed per hour. The computation for the total lumens required to give a certain illumination intensity in foot-candles is as follows:

[1] This ratio refers to the light received by the object illuminated and should not be confused with the ratio of 20 to 1 for brightness contrast previously given under shading of lamps, which refers to the light radiated by the object. For example, a blackboard and a white sheet of paper on it may receive the same amount of light, but the latter will reflect much more light than the former, thus causing a marked brightness contrast between the two surfaces.

[2] The flux is measured in lumens. A lumen is the unit of light flux and is the quantity of light required to illuminate 1 square foot of area to an average intensity of 1 foot-candle.

FIG. 485.

N = number of lamps.
L = lumens output per lamp.
E = coefficient of utilization.
A = area of floor or horizontal work plane in square feet.
I = illumination intensity in foot-candles.

$$\frac{N \times L \times E}{A} = I$$

that is, the number of lamps multiplied by the output per lamp in lumens, multiplied by the coefficient of

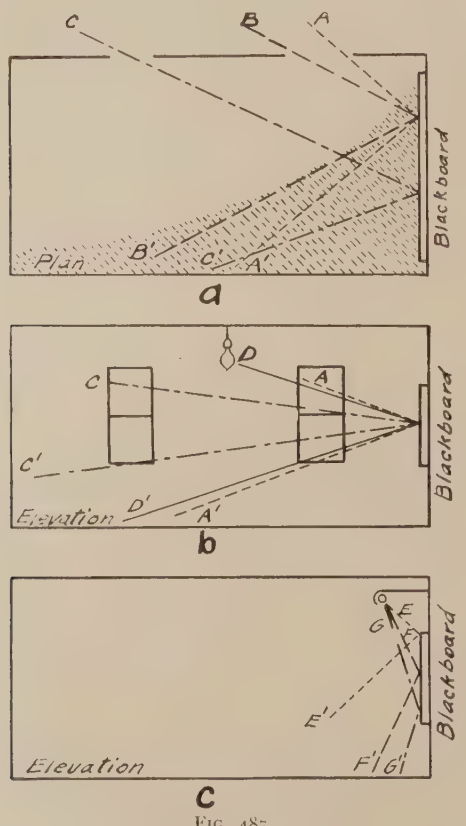


FIG. 487.

utilization, divided by the area of the horizontal work plane in square feet, gives the illumination intensity in foot-candles.

If the size of the lamps is to be ascertained the computation is made thus:

$$L = \frac{I \times A}{N \times E}$$

To illustrate by an example, assume a room whose floor (also work plane) is 30 feet by 18 feet (9.1 m. by 5.5 m.) to be lighted by a semi-indirect system from six fixtures containing one lamp each. It will also be assumed that the ceiling is highly reflecting, the walls moderately reflecting, and the illumination intensity desired is 5 foot-candles. The luminous output required of each of the six lamps will be found by substituting the assumed values in the equation, thus:

$$L = \frac{5 \times 30 \times 18}{6 \times 0.30} = 1500 \text{ lumens}$$

Allowing a depreciation factor of 20 per cent as representing a well-maintained installation, the lumens actually required would be $\frac{1500}{0.8} = 1875$ lumens. If gas-filled tungsten lamps are considered, whose average output under service conditions is 12 lumens per watt, it is

FIG. 486.

seen that a 150-watt lamp in each fixture will give the desired results.

If gas-mantle lamps are considered, whose average output in lumens under service conditions is 250 lumens per cubic foot of gas consumed per hour, it is seen that a lamp consuming 5 cubic feet of artificial gas per hour will be satisfactory in each fixture.

The above example is intended solely to illustrate the method of computation. Estimates of the illumination intensity obtained from an actual installation may also be made by a similar computation.

Suitable switching and controlling arrangements should be made to permit of lighting one or more lamps independently as conditions may require.

The teacher's desk may be illuminated by one of the overhead lighting units, or, if necessary, by a desk lamp.

With the usual lighting equipments the distance between the units should not exceed one and one-half times the height of the apparent source of illumination above the working level.

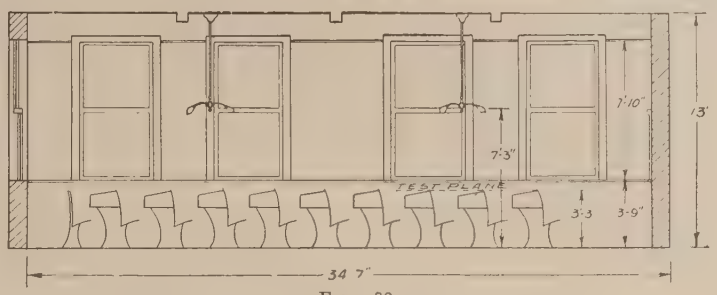


Fig. 488.

Blackboards. — Blackboards should be of minimum size practicable and should not be placed between windows. Their position should be carefully determined so as to eliminate the glare due to specular reflection of images of either artificial or natural light sources directly into the eyes of occupants of the room. The surface of blackboards should be as dull as possible, and this dullness should be maintained.

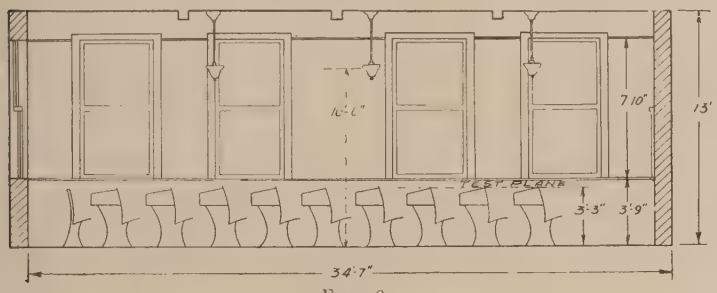


Fig. 489.

Glare, due to specular reflection from blackboards, may be reduced or eliminated by lighting them by means of properly placed and well-shaded local artificial light sources.

In Figure 487 are shown some simple graphical considerations of blackboard lighting. In (*a*) is shown a plan view of a room with windows on one side. Rays of light are indicated by A, B, and C in a horizontal projection. These are supposed to come from bright sky. By the application of the simple optical law of reflection — the angle of incidence is equal to the angle of reflection — it is seen that pupils seated in the shaded area will experience glare from the blackboards on the front wall. In (*b*) is shown the vertical projection of the foregoing condition. It will be apparent from this graphical illustration that by tilting the blackboard away from the wall at the top edge, the pupils in the back part of the room will be freed from the present glaring condition. Whether or not this tilting will remedy bad conditions may be readily determined in a given case. In (*b*) the effect of specular reflection of the image of an artificial light source is shown by D. In (*c*) is shown a proper method of lighting blackboards by means of artificial lighting units. This will often remedy bad daylight conditions, whether due to an insufficient illumination intensity of daylight or due to reflected images of a patch of sky.

In order to avoid excessive brightness contrast which is trying to the eyes, blackboards should not be placed on a white or highly reflecting wall.

Rehabilitating the Lighting of Old Buildings. — This will be illustrated by an actual case where the artificial lighting of a classroom was made satisfactory at a small expense. In Figure 488 is shown an elevation of a section of the classroom showing the old fixtures. In Figure 490 the circles containing crosses ⊕ indicate the positions of the two old fixtures in this room. The chief objections to this old system were as follows:

(1) The lighting units were hung too low, so that eye-fatigue resulted from the bright sources in the visual field.

(2) The light sources were not shielded from the pupils' eyes.

(3) Two fixtures are insufficient to provide satisfactory illumination over the entire work plane in a room of

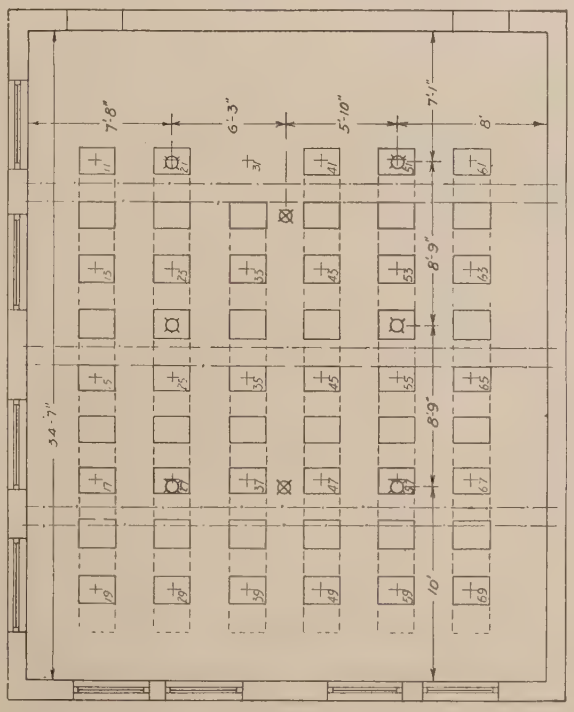


Fig. 490.

the dimensions shown. This unsatisfactory condition was remedied by means of six fixtures placed as indicated by the circles ⌑ in Figure 490.

These fixtures, shown in elevation in Figure 489, consisted of inverted diffusing glass shades containing one lamp each. The dimensions of the room are shown in the illustration.

Maintenance. — A systematic maintenance should be provided in order to insure against depreciation in the illumination intensity due to burned-out lamps, broken gas mantles, discoloration, etc., and to accumulations of dirt upon the lamps, and upon the surfaces of the reflecting and transmitting media. It is found in practice that carelessness in this respect may easily reduce the effective illumination by 50 per cent, especially in indirect and semi-indirect lighting.

Issued April 30, 1918.

CHAPTER XXVIII

STANDARDS OF SCHOOLHOUSE PLANNING

By Frank Irving Cooper, *Architect, Chairman, National Education Committee on Standardization of Schoolhouse Planning and Construction*

General Statement. Rules for Measuring and Tabulating Buildings. Application of Measurements. Division of Floor Area. Functions of the Divisions of Floor Areas. (1) Administration. (2) Instruction. (3) Accessories. (4) Stairs and Corridors. (5) Flues. (6) Walls and Partitions. Results from Eighty Buildings Measured. A Vision of the Future. Addenda: Standard Types of Construction.

General Statement. — Changes in the country's educational program are creating new demands in schoolhouse construction. To satisfy these demands, to produce schoolhouses which shall meet the new conditions, is the main issue now confronting the architect.

The changes in education are due to economic and academic causes. The world war has been a factor in both these phases. From a purely economic standpoint it is necessary to conserve. The architect must be sure that all material is used, and all energy is expended, to secure the greatest net result.

The world war has accelerated the general trend toward a more flexible educational system. The educator considers his work from a new point of view. The old-fashioned formal program, with its stereotyped methods, was the inevitable product of an age which demanded that pupils in a given grade should, on a given day, recite practically the same lesson in standard graded schools from coast to coast.

That old method is giving way to a new one, one which considers the pupil who may have only a few school years in which to prepare for his life work. Universalism in education is yielding to individualism, the educational program which caters to the individual child.

The increasing flexibility of educational courses, the changes which this imposes upon schoolhouse design, and the economic pressure, all emphasize the imperative need of basic or fundamental standards in schoolhouse planning.

The architect must be his own translator. That is, he must recognize the changes in educational methods and must translate the new terms of the educational world into necessary changes in his own architectural world.

To guide him in this translation he must work or build upon a secure foundation. That foundation is made up of certain standards of construction and design. If he lacks those standards no amount of mental effort, no thrust of individual cleverness, not even a flight of genius, will bring forth from his draughting board an efficient schoolhouse plan.

The final test of structural worth in a schoolhouse is its working efficiency. A school building may well be called a factory, under corporate control. The superintendents, principals, and teachers compose the operating force. The school board constitutes the board of directors. The pupils form the raw material. They are graduated as the finished product of the educational factory. The quality of their educational preparation for life is the dividend which is reaped by the stockholders, who are the parents and taxpayers. It is the duty of the committee-directors and faculty-operatives to secure a high dividend rate from their educational plant. It is the duty of the school architect to provide them with a plant which shall be 100 per cent efficient, so far as the structural element is concerned.

This duty is one which the individual architect may not shirk, if he is to be equal to the new conditions. If he cannot, in himself, meet the requirements, he will be outstripped by rivals who are competent.

There is a high preventive factor, too, in knowledge of standards for schoolhouse planning. It is extravagant, from financial and utilitarian viewpoints, and it is dangerous, from the angles of safety and hygiene, to permit wastage of floor area when apportioning the space units which are to be used for instruction purposes in a school building and in apportioning the spaces which are to be used for administration and other purposes.

The *American Architect* of November 6, 1918, said in an article on "Standardized Schoolhouse Design":

"The building has a very important influence on the occupant, and to produce a satisfactory public-school pupil the teaching process must include the standard educative essentials and the process be carried on in a building containing certain physical characteristics and equipment which is complementary to the mental processes, hence the development of standard building requirements. . . . If the architect has had the experience and acquired the knowledge necessary to enable him to design a satisfactory building, the possession of certain successful standards may fortify him in combating the possible ill-conceived ideas and demands of untrained school board members. If he has not had this experience and its attendant judgment it will increase his knowledge and aid him in the solution of the problem."

In other words, knowledge of planning standards is both offensive and defensive equipment. It fortifies the architectural strategist against attack and sustains him in advancing his forces.

We learn from the errors of our predecessors. When this nation was young its school buildings were not

HATCHED STATES SHOW THE LOCATION OF BUILDINGS TABULATED BY THE COMMITTEE
THOSE STATES WHICH HAD LAWS ON CONSTRUCTION IN 1915 ARE CROSS HATCHED IN ADDITION
NATIONAL EDUCATION ASSOCIATION
DEPARTMENT OF SCHOOL ADMINISTRATION
COMMITTEE ON STANDARDIZATION OF SCHOOLHOUSE PLANNING AND CONSTRUCTION

FIG. 491.

"located." They "just happened." The school lot was all too often the least valuable site which could conveniently be found in the community. The school building, as we are told by Barnard in his book on "School Architecture" and by May Ayres in "A Century of Progress in Schoolhouse Construction," was usually an unstudied affair situated at the crossroads.

The increasing care exercised in locating schoolhouses and the subordination of land values to educational needs make it all the more incumbent upon the schoolhouse architect to justify the municipal sacrifices. His justification rests upon the distribution he makes of his schoolhouse area or floor space.

The factors of time and space in schoolhouse operation may not be employed to the point of the absolute ideal. The ideal employment of school hours would be to use them all solely for instruction. The ideal employment of schoolhouse space would be to use it all solely for instruction.

But the complex curriculum of modern educational courses will not allow all the school hours to be devoted to instruction. The merest glance at a school program shows this. Reduction of time wastage is the duty of the educator.

The ideal use of the school area or floor space is impossible on account of the requirements of other physical factors than those of instruction. In constructing a schoolhouse it is necessary to have exterior walls to close in the structure, interior partitions to divide this inclosed area into rooms, flues to convey air and gases, corridors to allow passage from room to room, and administration space. The latter includes provision for heating, ventilation, and sanitation. All these demands for floor space must be met by the architect. Obviously, the space that is left may be devoted to instruction.

The instruction area in a school building is the actual producing space of the educational factory. This production unit should be as large as possible and be consistent with safety and adequate administration.

The school structure must be adapted to the work which is to be carried on there. The building must have the right shape, size, and arrangement of rooms. It must be properly heated, lighted, and ventilated. It must have suitable sanitary equipment.

The design of the modern school structure should be elastic, not unyielding. It should be so built that floor spaces may be put, if necessary, to other uses than those originally intended.

To secure these essentials and to proportion them so that they will dovetail into a harmonious and efficient whole, it is primarily necessary to work from certain standards in planning. These standards are now available for the school architect.

Until 1916 practically no consideration had been given to the relative amount of floor space that should be allotted in a school structure to the various operating functions of the educational system carried on therein. In that year the National Education Association appointed a committee to consider standardization of schoolhouse planning and construction.

It was not and it is not now the intention of the National Education Association to bind or even to hamper the architect in his work. Rather it is the desire of the Association's Department of Administration, which

directly appointed this Committee on Standardization, to provide both architect and educator with a measure by which a schoolhouse plan may be scaled so that the working efficiency of the completed structure may be determined before actual construction is begun.

The committee made tabulations from plans of one hundred and fifty school buildings, located in twenty-six different states of this country. (See Figure 491.)

This chart shows the locations of the one hundred and fifty schools. The most representative parts of the country were covered by the committee's investigation. The committee was surprised to observe that the nation-wide variation in instruction floor-space existed in the various states separately. One might assume that different state educational systems might account for the variation from coast to coast. But state boundaries inclosed similar variations in the percentage of floor areas for instruction.

Rules for Measuring and Tabulating Buildings. — A set of rules has been framed for measuring a schoolhouse plan for standardization. These rules, numbering twenty, are as follows:

1. Every foot of space of the area of the building is to be included in the tabulation. The sum of the areas of the basement and each floor is called 100 per cent. Tabulations are to be checked until the sum of the various space items check within one-half of one per cent of the total area.

2. Line of measurement for area of all floors is to be taken at the outside of exterior walls. Deduct all recesses which are the full story height.

3. The area of basement floor is to be measured from same line as outside wall of first floor.

4. Compute each floor and mezzanine separately.

5. The area of light wells, courts, air shafts, etc., is not to be included in floor area.

6. Areas of arcades, open porches, uncovered corridors, pergolas, and open-air theaters or auditoriums are to be figured separately.

7. In rooms and auditoriums which extend through more than one story the area of such space shall be deducted from the floor or floors through which it extends.

8. In the case of an assembly hall or gymnasium which has a balcony, the area of such balcony shall be taken separately.

9. In figuring walls or partition areas, no door or window openings shall be deducted, but the wall shall be figured solid, as though no openings occurred.

10. Exterior walls and interior partitions are to be figured the finished thickness, including any lath and plastering.

11. Large piers occurring in rooms are to be deducted from floor areas and added to wall areas.

12. Flues are to be figured to include all surrounding walls and partitions except interior walls and partitions figured under 10.

13. Chimneys are to be figured in as flue areas.

14. Where closets, bookcases, or dead spaces occur in a bank of flues, same are to be figured in as flue area.

15. Stairs extending a full story in height are to be taken as stair area. Steps not a full story in height are to be taken as part of the floor area of the room or corridor in which they occur.

16. Area of each individual space is to be taken separately in accordance with schedule.

17. Wardrobes are figured inside the walls.

18. Rooms having wall cabinets are to be figured from partition walls. Cabinets are to be included with the room.

19. Waiting spaces, closets, supply rooms, toilets, etc., in connection with offices shall be included with the office with which they occur.

20. Toilets, showers, storage room, supply rooms, etc., when connected with a main division, shall be taken separately but be included with the total area of that division.

Application of Measurements. — In applications of these measurements to the plan the chief operating divisions of the school structure must be considered. A schoolhouse, in its simplest architectural expression, consists of a certain total floor space which is to be divided into units for operating the educational plant.

Division of Floor Area. — Educators and architects have agreed upon six main divisions of floor space; also upon the relative value of each, as expressed in the percentage of the total floor space which should be allotted to it. Call the entire area of all floors one hundred per cent. These divisions and their relative values are:

Division	Floor Area
Administration	not more than 12 per cent.
Instruction	not less than 50 per cent.
Accessories	not more than 3 per cent.
Stairs and corridors	not more than 20 per cent.
Flues	not more than 5 per cent.
Walls and partitions	not more than 10 per cent.

Observe that this grouping sets aside not less than one-half the total floor area of the structure for the division of instruction. The allotments for the other five divisions are specified as " not more than " certain percentages, — as, not more than 20 per cent of the whole floor area for stairs and corridors.

This minimum of fifty per cent for instruction is based upon the hypothesis that school buildings are planned primarily for instruction of pupils, and that this limit per cent is necessary if the structure is to meet the tests of economy and efficiency.

The committee standards on schoolhouse planning are meant to have a certain elasticity. While the whole area given to Instruction must never fall below fifty per cent, it may exceed that percentage. In fact, the more it can exceed it, other considerations being equal, the more efficient will be the completed structure. On the other hand, the other divisions, such as Administration, Accessories and so on, may be allotted less than the percentage maximum quoted for each. But none of these five other divisions must ever exceed its percentage maximum.

Functions of the Divisions of Floor Areas. — Each of these allotment divisions is to include certain structural or educational functions, as follows:

Administration. — All floor area connected with government and maintenance of the school. It includes rooms for officials, instructors and medical department service and storage rooms, general wardrobes, sanitaries, and all space required for heating and ventilating equipments.

Instruction. — Library, kindergarten, art or drawing rooms, class and study rooms, music rooms, laboratories, domestic science, manual training, commercial arts, household arts, auditorium, gymnasium, drill halls, and swimming-pools.

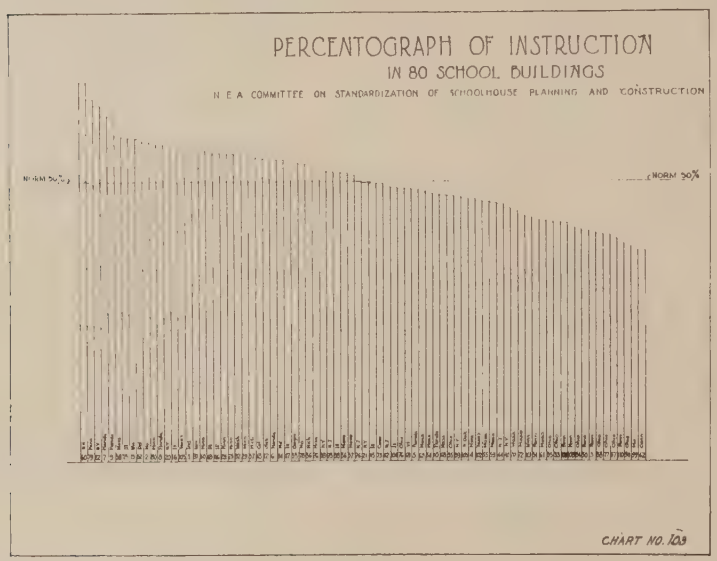

PERCENTOGRAPH OF INSTRUCTION
IN 80 SCHOOL BUILDINGS
N. E. A. COMMITTEE ON STANDARDIZATION OF SCHOOLHOUSE PLANNING AND CONSTRUCTION
NORM 50%
CHART NO. 109

Fig. 492.

Accessories. — Floor spaces which do not group under any of the other five main divisions, such as playrooms, general lunch rooms used for no other purposes, odd closets and storerooms.

Stairs and Corridors. — The channels of all ordinary means of circulation and service; they are essential to proper use of the building.

Flues. — All vertical flues for conveying air or gases.

Walls and Partitions. — This division, also styled "Construction," includes the floor area occupied by the exterior walls and the interior partition.

Principles of safety form chief factors in the planning of some of these divisions. Walls and partitions, for example, are determined by engineering formulæ for strength of materials, by building regulations, and by consideration of good construction.

Flue areas are determined by natural laws which call for certain dimensions under certain fixed conditions to give a predetermined air movement laid out by the heating and ventilating engineer.

Stairways and exits should be located so that there will be no pockets or dead ends to corridors. Exits should be located so that no point in any floor area served by them should be more than 75 feet distant along the line of travel from an exit; except in buildings of Class A construction (see Addenda) in which a distance of 100 feet may be permitted.

Every stairway more than 5′–0′ in width should be provided with continuous intermediate handrail substantially supported.

Corridors should never be less than 8′–0′ in width. Main corridors should have a width of 48 inches for the first 50 persons to be accommodated thereby and six inches additional for each additional 50 persons or fraction thereof.

Results from Eighty Buildings Measured. — The results from the first eighty buildings which were tabulated have been arranged in graphic form. The graph for education is shown by Fig. 492.

This chart (Instruction) comprises all floor areas used directly for any activity educating the pupil. It also includes gymnasium, auditorium, and any space for organized play or recreation.

The percentage of floor space devoted to instruction is laid out by the vertical spaces to scale, using the horizontal line at the base as zero.

Note that the building on the extreme right has only 37.50 per cent of total floor area devoted to instruction, while the one on the extreme left gives 67.95 per cent. The norm for instruction in these eighty buildings is 50 per cent.

It will also be noted that forty of the eighty buildings give more than 50 per cent of their total floor area to instruction. Future school buildings should show considerable increase over the 50 per cent means.

The same method of procedure is applied to determine the space percentages allotted to the five other main divisions in apportioning floor area. A tabulation was worked out of the average per cent of space given to the respective divisions.

The committee found that the tabulations for all divisions gave average space percentages thus: Administration, 12; Instruction, 50; Accessories, 3; Stairs and Corridors, 20; Flues, 5; Walls and Partitions, 10.

The percentages thus determined have been adopted by the committee, with the proviso that the Instruction division shall have a minimum of 50 per cent and more if possible, and that the percentages set for the five other divisions shall be their maximum.

The result of the study of the committee is shown by Figure 493.

This chart, " The Candle of Efficiency," conveys at a glance the standards by which the excellence of apportionment of floor space for each of the main divisions of a school building may be judged.

The chief use of a schoolhouse is for educational work. A tabulation of any schoolhouse plan, compared with the per cents shown by the candle, will show how nearly the plan meets the standards of efficiency as worked out from plans of schoolhouses already erected.

The educator decides upon a certain program. Given this program, it is the province of the architect to supply the necessary space units for each requirement of that program. He must so distribute these space units that there shall be no wastage of floor area in the building. Also he must secure the maximum of safety, comfort, and convenience.

A factor to be considered in allotment of floor space to individual educational activities is the proportion of the day that this floor space is used. In manufacturing terms this is the " load factor."

If the school day is six hours and the school week five days, then the working time has thirty hours.

If a certain room is engaged in productive occupation thirty hours per week, its load factor is 100 per cent. If it is occupied but fifteen hours per week, its load factor is reduced to 50 per cent.

The logical test of efficiency in planning a school building is the proportion of the building which may be used for the manufacture of citizens, or, putting it another way, the proportion of the building which may be used for instruction purposes.

In the nearest possible approach to the ideal, at least 50 per cent of the entire floor area of the building may be used for instruction purposes 100 per cent of the school time.

Waste hours in the use of a school plant are distinctly the fault of the educator and of the community. But waste space is usually the fault of the architect.

A Vision of the Future. — The school architect creates something which may be of tremendous aid to the educator in his work with school children.

The architect must be a man of vision. He must make it possible for the teacher to work out new ideas. He must have in mind provision for the school of to-morrow, a school of new standards, which will require floor space for new kinds of educational activities.

This school of to-morrow will need a great variety of different kinds of floor space, on the assumption that the educational subjects are to have different methods of treatment and that different forms of study will be pursued.

This school building of to-morrow will have standards in simplicity and a quality of economy relatively rare at present. Every building will represent something more of human personality, personalities of the classroom, of teacher and class, personality in shop and laboratory, personality in entrance halls and reception rooms, all indicating the spirit of the educators who are directing the school.

The school building of to-morrow must set a standard for the entire community. It will be used by parents as well as by children. It will represent a spiritual

NATIONAL EDUCATION ASSOCIATION
DEPARTMENT OF SCHOOL ADMINISTRATION
LESS WASTE
GREATER EFFICIENCY
THIS CANDLE IS TO SHOW THE DIVISIONS INTO WHICH THE TOTAL FLOOR AREA OF A SCHOOL BUILDING IS DIVIDED
THE TOTAL FLOOR AREA IS TAKEN AS 100 PER CENT
WALLS & PARTITIONS NOT OVER 10 %
FLUES NOT OVER 5 %
STAIRS & CORRIDORS NOT OVER 20 %
ACCESSORIES NOT OVER 3 %
INSTRUCTION NOT LESS THAN 50 %
ADMINISTRATION NOT OVER 12 %
THE CANDLE OF EFFICIENCY
IN SCHOOLHOUSE PLANNING
TRY THIS MEASURE ON YOUR SCHOOL BUILDING THEN SEND THE RESULTS TO
COMMITTEE ON STANDARDIZATION OF SCHOOL BUILDINGS
FRANK IRVING COOPER
CHAIRMAN • 33 CORNHILL • BOSTON
NOTE: TABULATIONS SHOW MANY SCHOOL BUILDINGS WITH ADMINISTRATION 10% STAIRS AND CORRIDORS 17% FLUES 3% AND INSTRUCTION 57 PER-CENT •
COPYRIGHT 1918 BY FRANK IRVING COOPER

FIG. 493.

ideal. It will represent democracy, free education, hospitality and good-will to every person entering its portals.

As this educational problem widens, so will the problem of school architecture broaden with it. The complexity of architectural detail will increase and, more than ever, it will be the imperative necessity of the school architect to have his plan founded upon the rock of standardization.

ADDENDA

Definitions and Standards of Types of Schoolhouse Building Construction adopted by Committees of the

National Education Association, National Association of School Accounting and Business Officials of Public Schools, National Fire Protection Association, and *The American Institute of Architects.*

Type A. A building constructed entirely of fire-resistive materials, including its roof, windows, doors, floors and finish.

Type B. A building of fire-resistive construction in its walls, floors, stairways and ceilings, but with wood finish, wood or composition floor surface, and wood roof construction over fireproof ceiling.

Type C. A building with masonry walls, fire-resistive corridors and stairways, but with ordinary construction otherwise, *i.e.*, combustible floors, partitions, roof and finish.

Type D. A building with masonry walls, but otherwise ordinary or joist construction and wood finish.

Type E. A frame building constructed with wood above foundation, with or without slate or other semi-fireproof material on roof.

SUPPLEMENTARY ILLUSTRATIONS

The following figures represent additional illustrative material as follows:

Chapter V. Organization of the Elementary School as Affecting Buildings, Figures 494–585

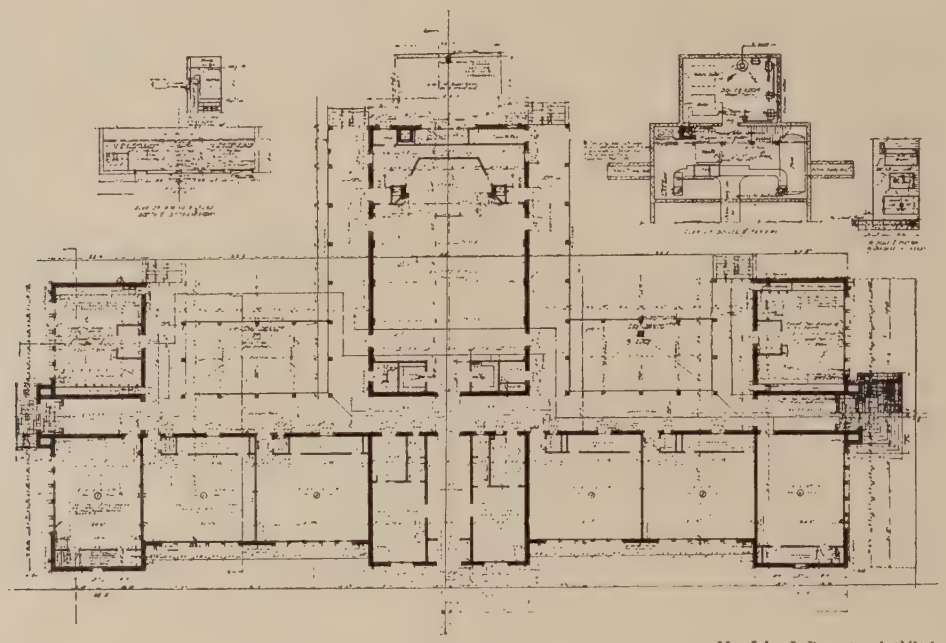
Chapter VII. Organization of the High School as Affecting Buildings, Figures 586–669

Mr. John J. Donovan, Architect

FIG. 494. — MCKINLEY SCHOOL, FRONT ELEVATION, SAN LEANDRO, CALIFORNIA.

Mr. John J. Donovan, Architect.

FIG. 495. — MCKINLEY SCHOOL, MAIN ENTRANCE, SAN LEANDRO, CALIFORNIA.

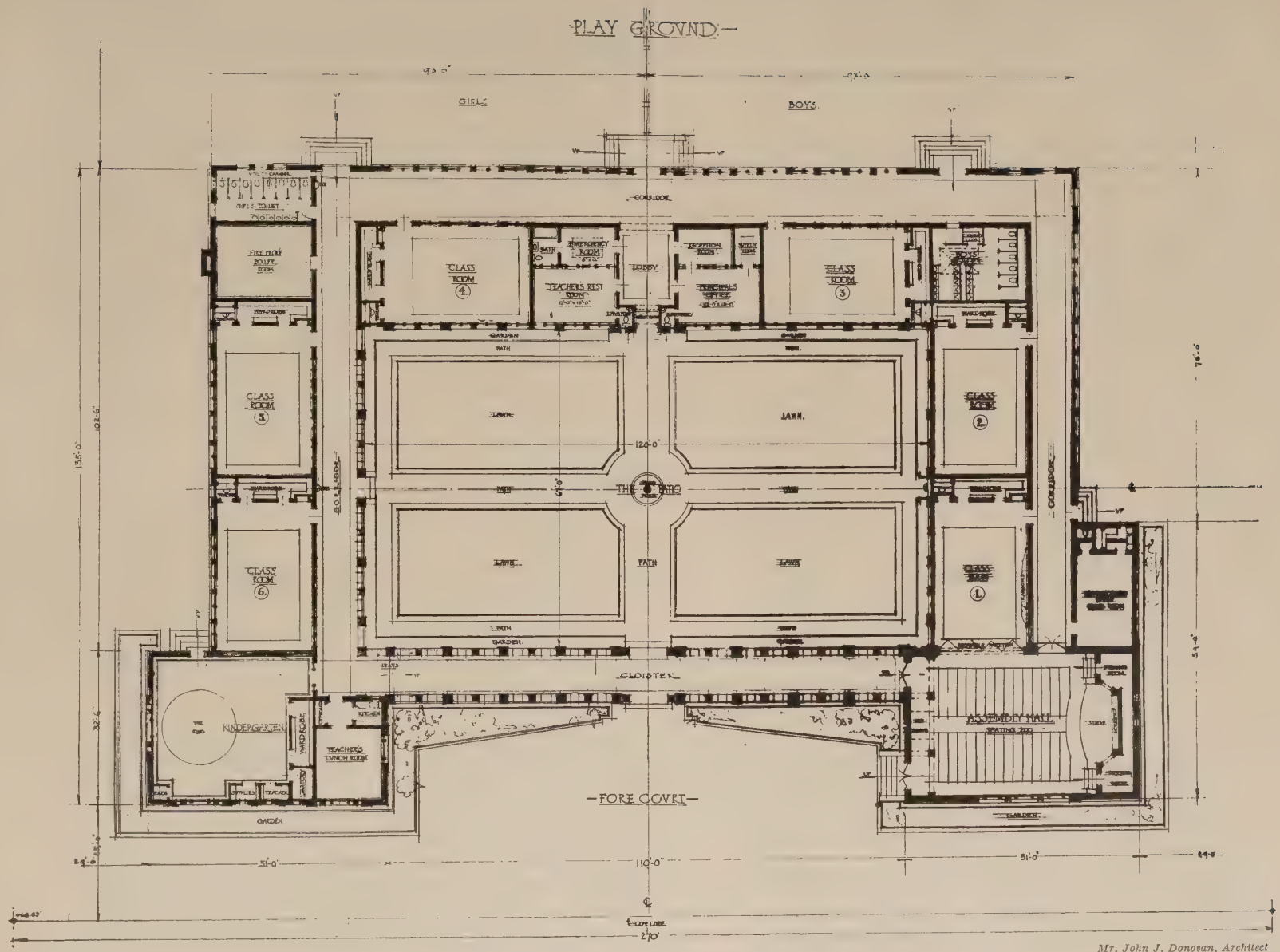


Mr. John J. Donovan, Architect.

FIG. 496. — MCKINLEY SCHOOL, FLOOR PLAN, SAN LEANDRO, CALIFORNIA.

Mr. John J. Donovan, Architect.

FIG. 497. — WASHINGTON ELEMENTARY SCHOOL, FRONT ELEVATION, SAN LEANDRO, CALIFORNIA.



Mr. John J. Donovan, Architect

FIG. 498. — SANTA FE ELEMENTARY SCHOOL, OAKLAND, CALIFORNIA.

Mr. John J. Donovan, Architect.

FIG. 499. — SANTA FE ELEMENTARY SCHOOL, FRONT ELEVATION, OAKLAND, CALIFORNIA.

Mr. John J. Donovan and Mr. Louis P. Hobart, Associate Architects.

FIG. 500. — LOCKWOOD ELEMENTARY SCHOOL, FRONT ELEVATION, OAKLAND, CALIFORNIA.

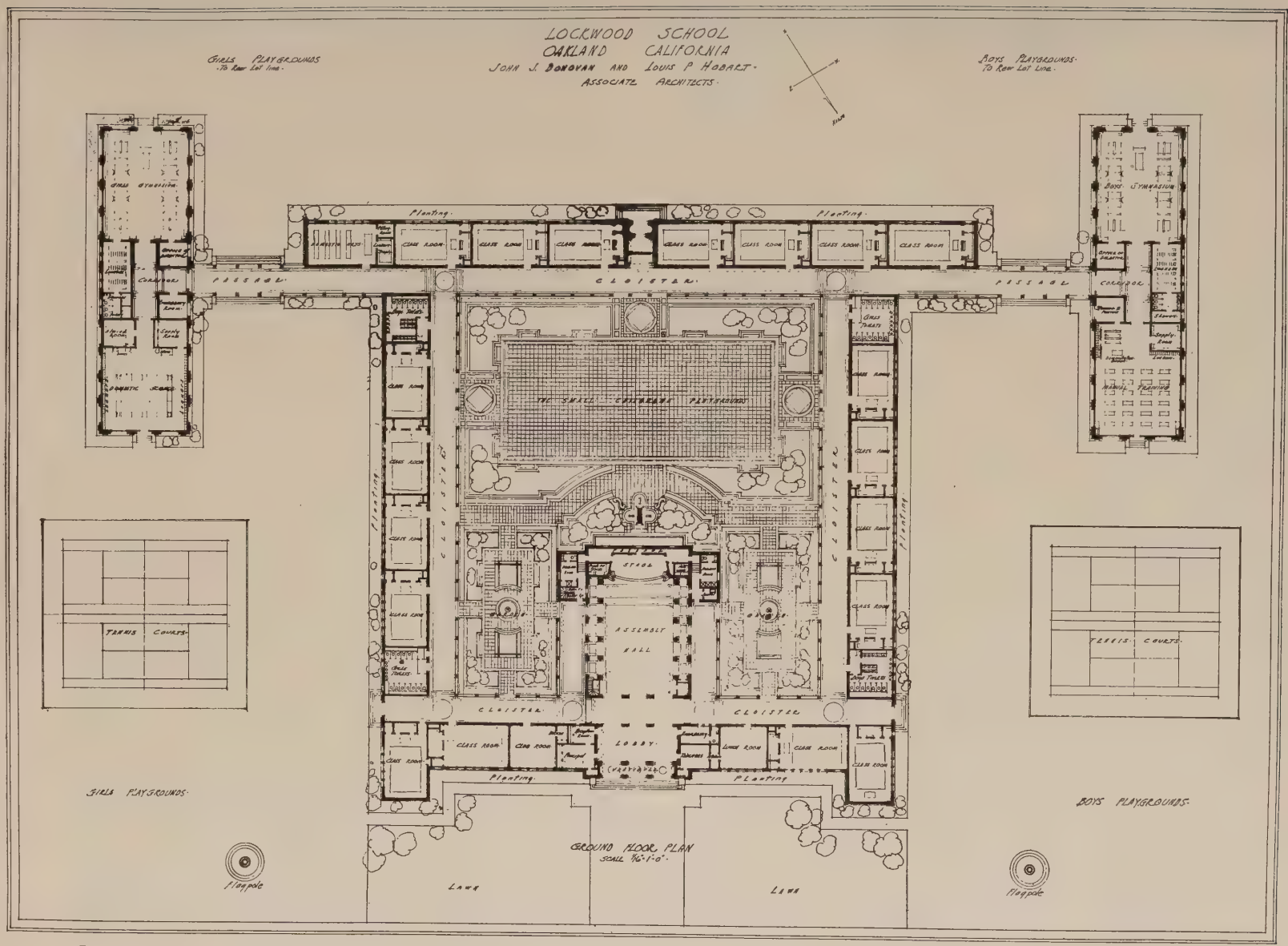


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FIG. 501.

Mr. John J. Donovan, Architect, and Mr. Louis P. Hobart, Associate Architect.

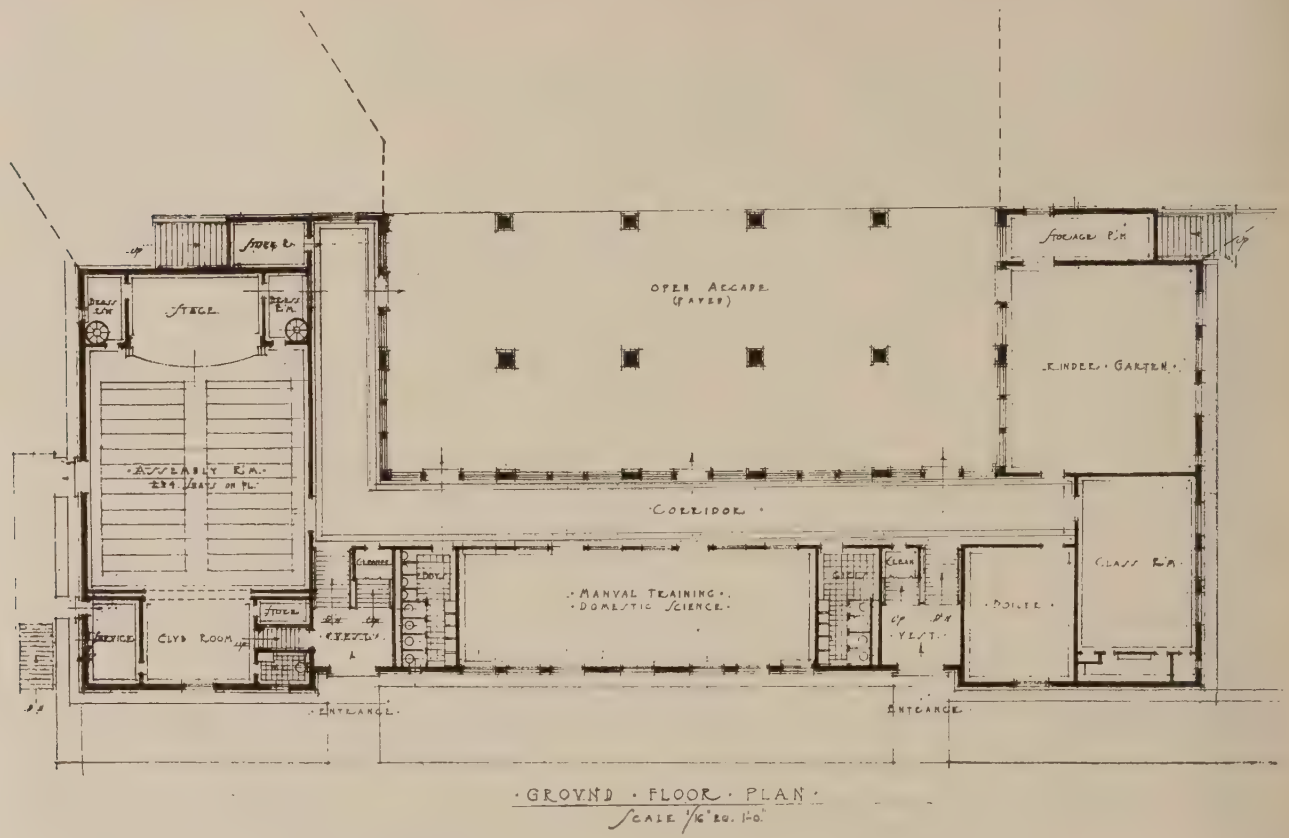
FIG. 502. — LOCKWOOD ELEMENTARY SCHOOL, PATIO, CALIFORNIA.

Mr. John J. Donovan, Architect.

FIG. 503. — MCCHESNEY ELEMENTARY SCHOOL, FRONT ELEVATION, OAKLAND, CALIFORNIA.

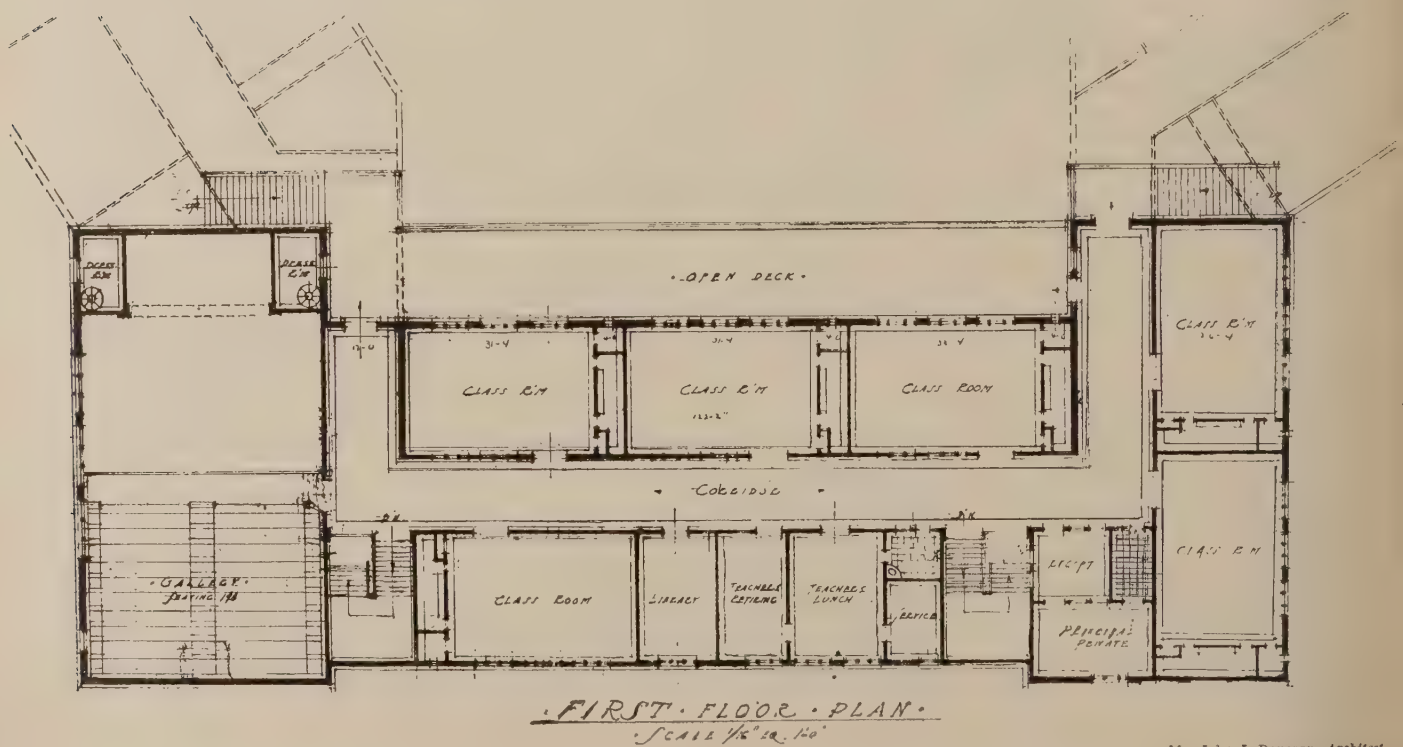
Mr. John J. Donovan, Architect.

FIG. 504. — MCCHESNEY ELEMENTARY SCHOOL, TERRACE AT REAR FOR OPEN-AIR STUDY, OAKLAND, CALIFORNIA.



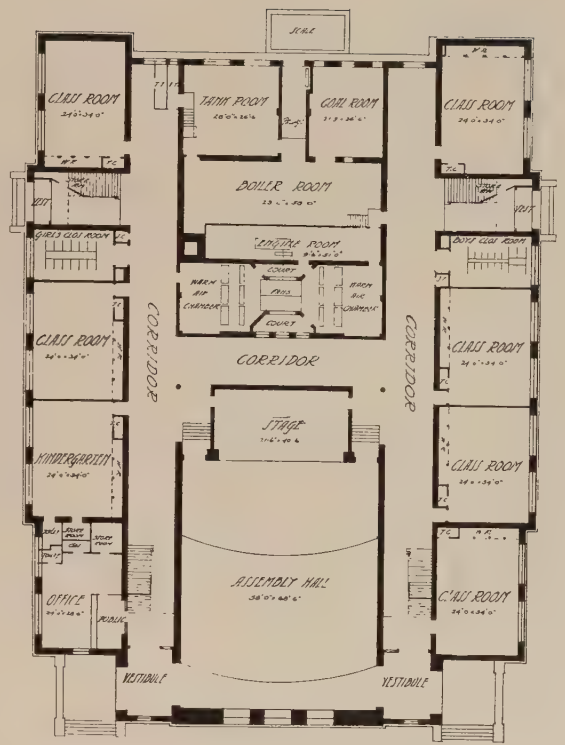
Mr. John J. Donovan, Architect.

FIG. 505. — McCHESNEY ELEMENTARY SCHOOL, GROUND FLOOR PLAN, OAKLAND, CALIFORNIA.



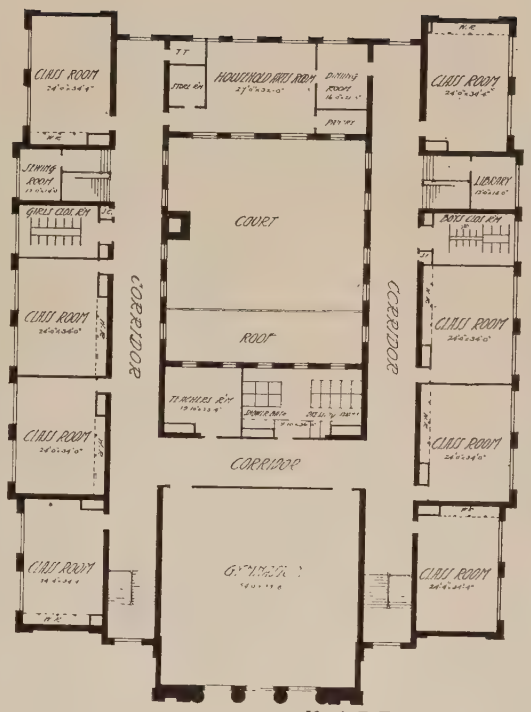
Mr. John J. Donovan, Architect.

FIG. 506. — McCHESNEY ELEMENTARY SCHOOL, FIRST FLOOR PLAN, OAKLAND, CALIFORNIA.



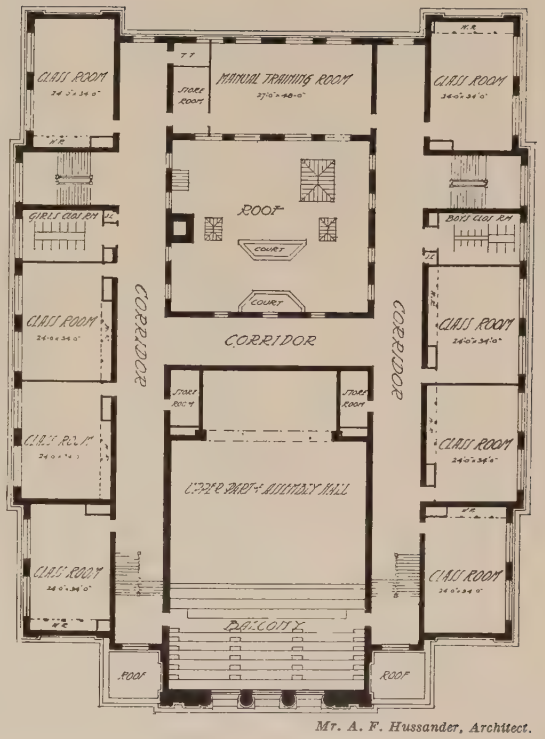
Mr. A. F. Hussander, Architect.

FIG. 507. — SHEPARD SCHOOL, FIRST FLOOR PLAN, CHICAGO, ILLINOIS.



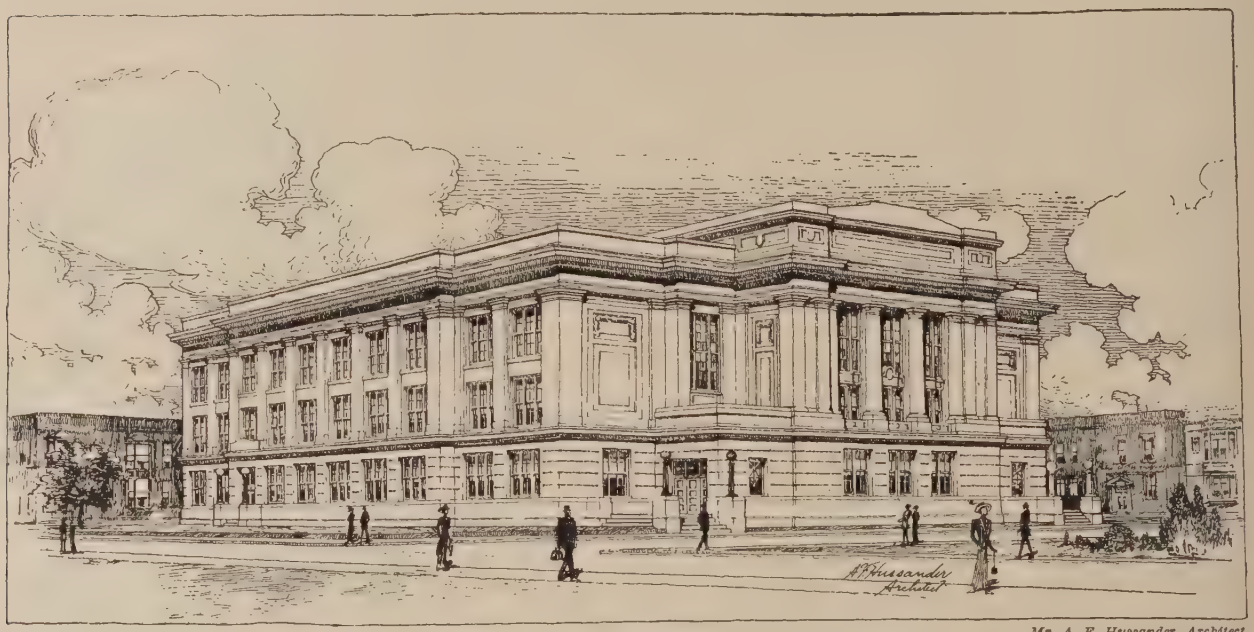
Mr. A. F. Hussander, Architect.

FIG. 508. — SHEPARD SCHOOL, SECOND FLOOR PLAN, CHICAGO, ILLINOIS.



Mr. A. F. Hussander, Architect.

FIG. 509. — SHEPARD SCHOOL, THIRD FLOOR PLAN, CHICAGO, ILLINOIS.

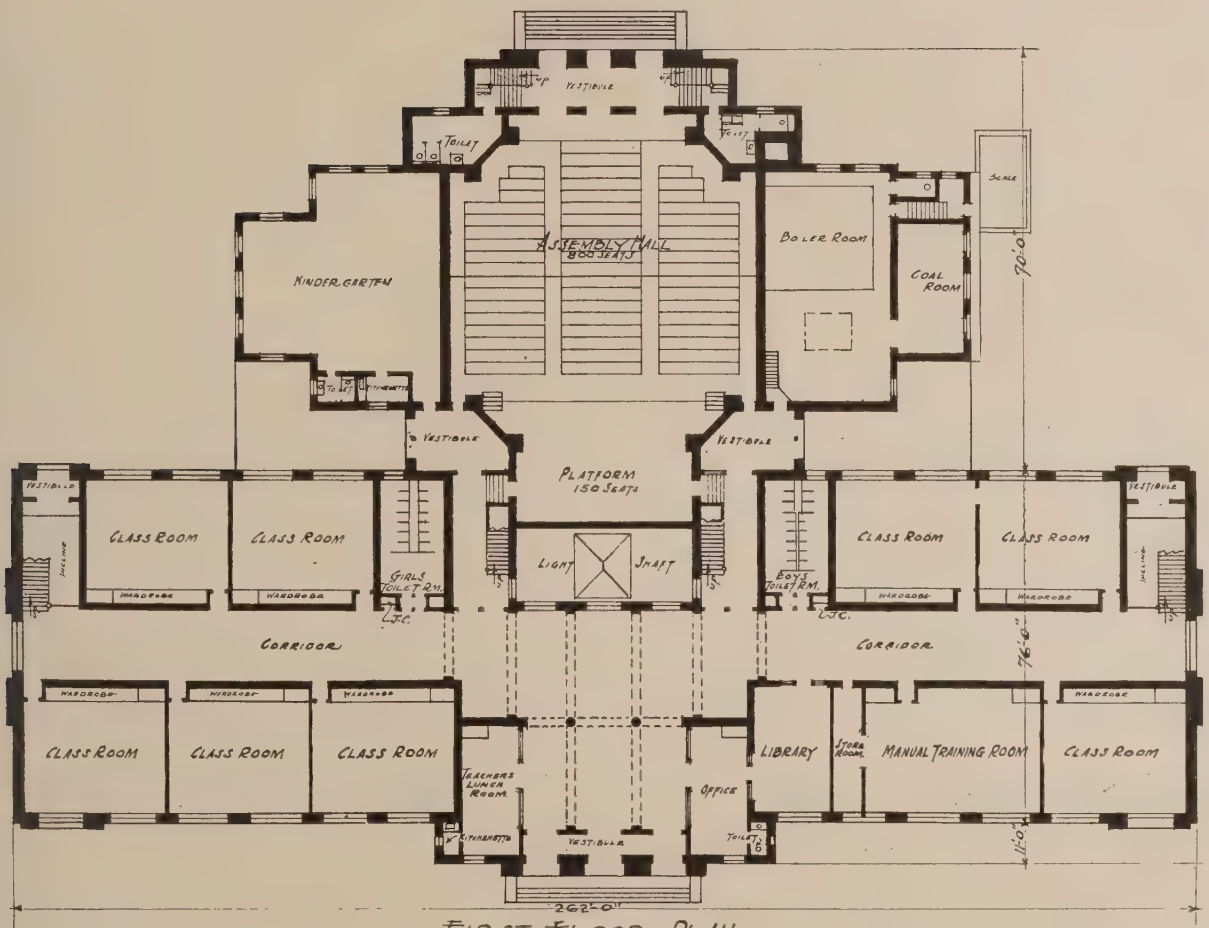


Mr. A. F. Hussander, Architect.

FIG. 510. — SHEPARD SCHOOL, PERSPECTIVE, CHICAGO, ILLINOIS.

Mr. A. F. Hussander, Architect.

FIG. 511. — REZIN ORR SCHOOL, ELEVATION, CHICAGO, ILLINOIS.



FIRST FLOOR PLAN

·REZIN ORR PUBLIC SCHOOL·

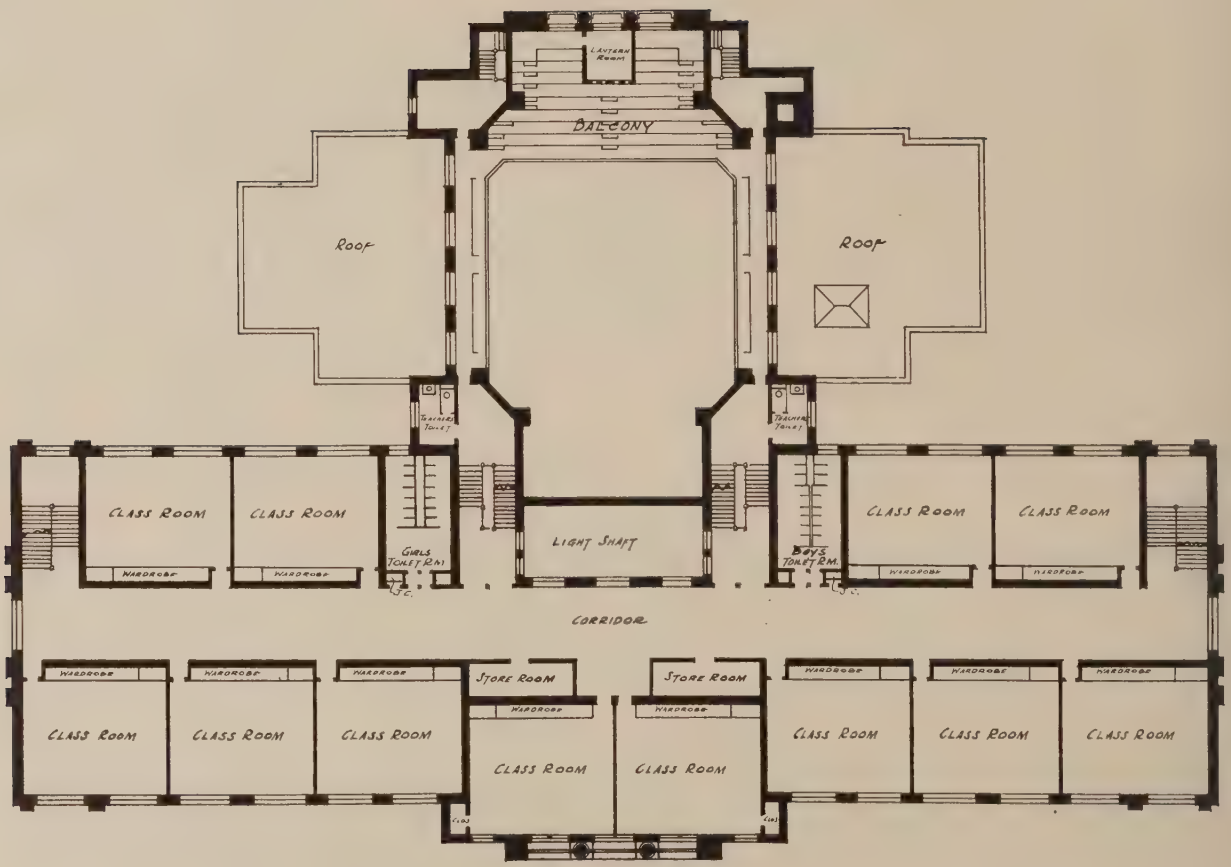
·COR·N·KEELER·AVE·& J·THOMAS·STR·

A.F.HUSSANDER·ARCHITECT·BOARD OF EDUCATION·CHICAGO.

SCALE 1/16" = 1'-0"

CONTAINING:
32 CLASS ROOMS (INCL'G KINDERGARTEN)
ASSEMBLY HALL.
GYMNASIUM.
HOUSEHOLD SCIENCE ROOM.
MANUAL TRAINING ROOM.
OFFICE & LIBRARY.
TEACHER'S LUNCH ROOM.

FIG. 512.



SECOND FLOOR PLAN

REZIN ORR PUBLIC SCHOOL

COR. N. KEELER AVE. & THOMAS STR.

A. F. HUSSANDER, ARCHITECT. BOARD OF EDUCATION. CHICAGO.

SCALE $\frac{1}{16}$" = 1'-0"

FIG. 513.

THIRD FLOOR PLAN

REZIN ORR PUBLIC SCHOOL

COR. N. KEELER AVE. & THOMAS STR.

A. F. HUSSANDER, ARCHITECT, BOARD OF EDUCATION, CHICAGO.

SCALE 1/16" = 1'-0"

FIG. 514.

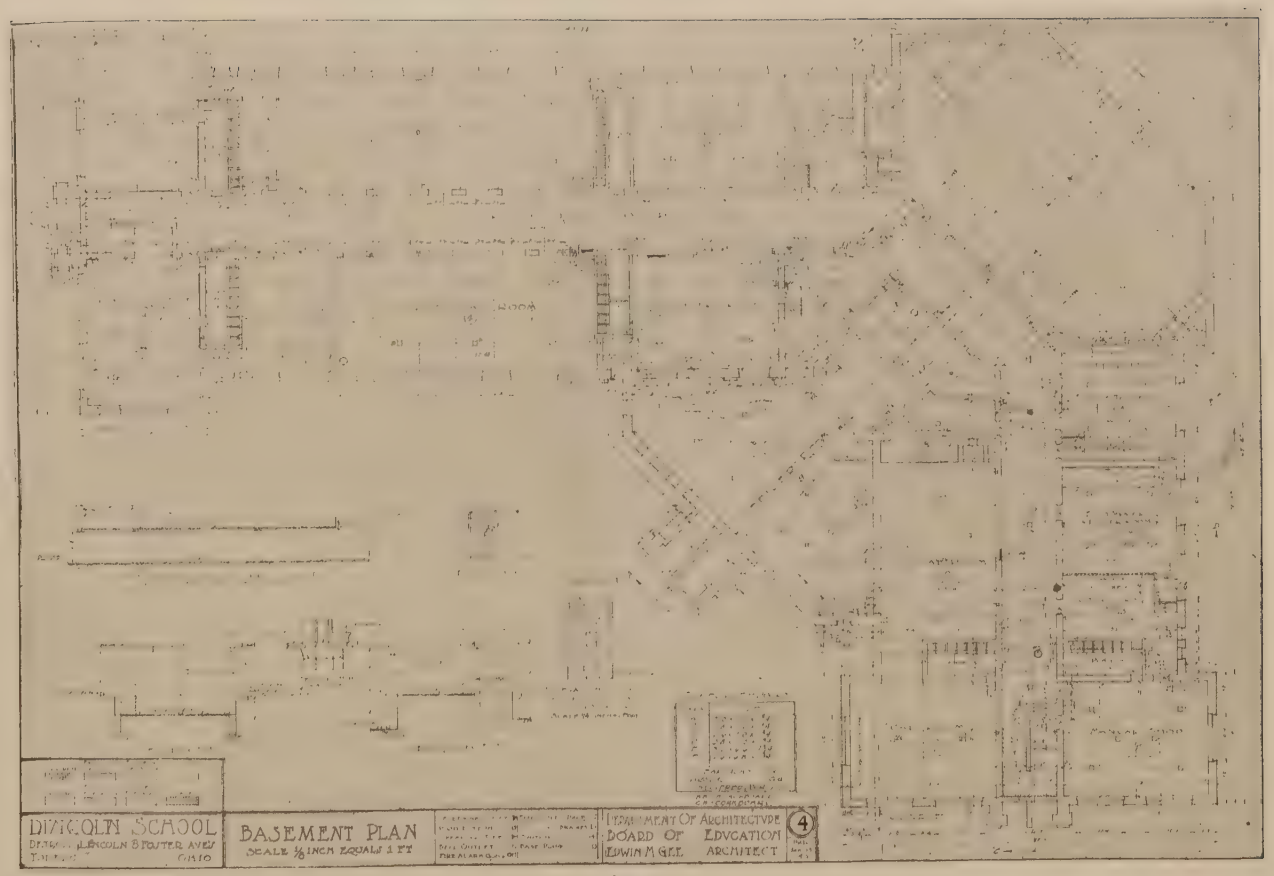

LINCOLN SCHOOL
BASEMENT PLAN
SCALE 1/8 INCH EQUALS 1 FT
DEPARTMENT OF ARCHITECTURE
BOARD OF EDUCATION
EDWIN M GEE ARCHITECT
4

FIG. 515.

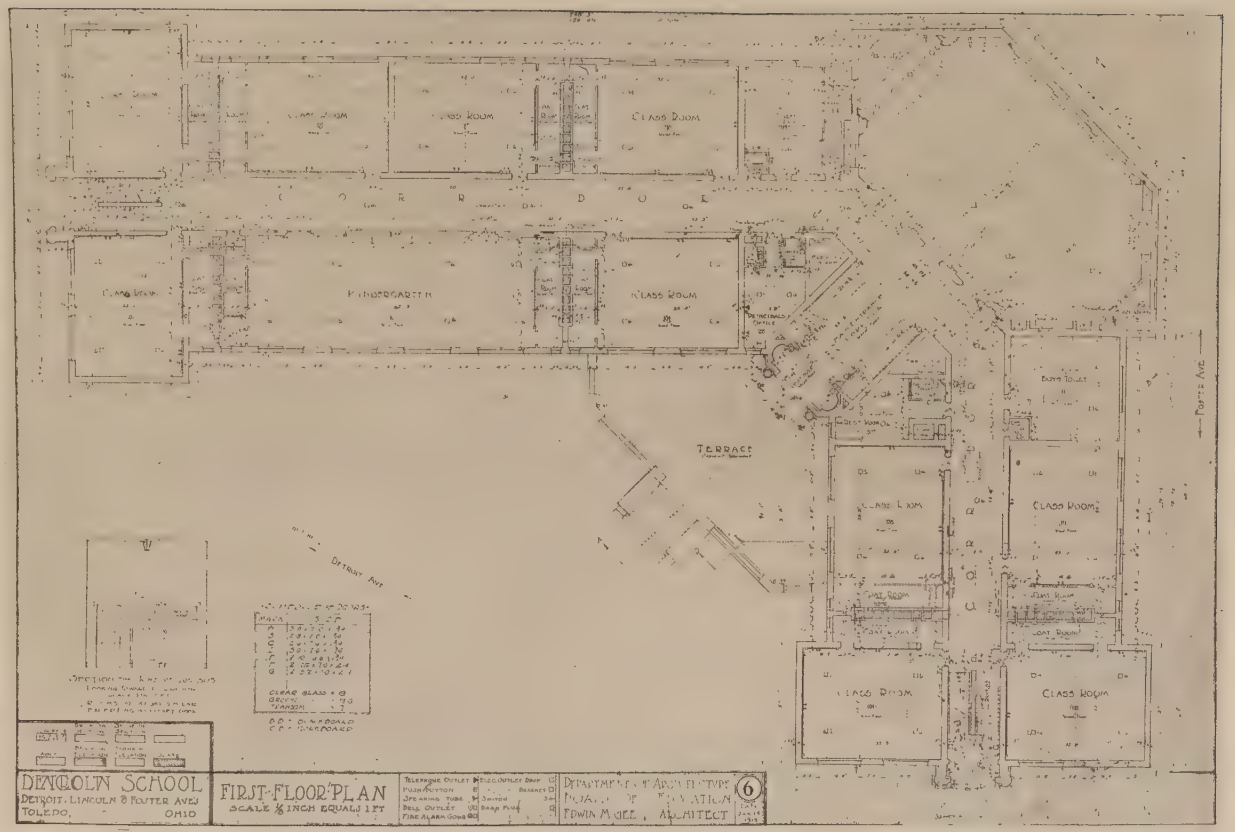
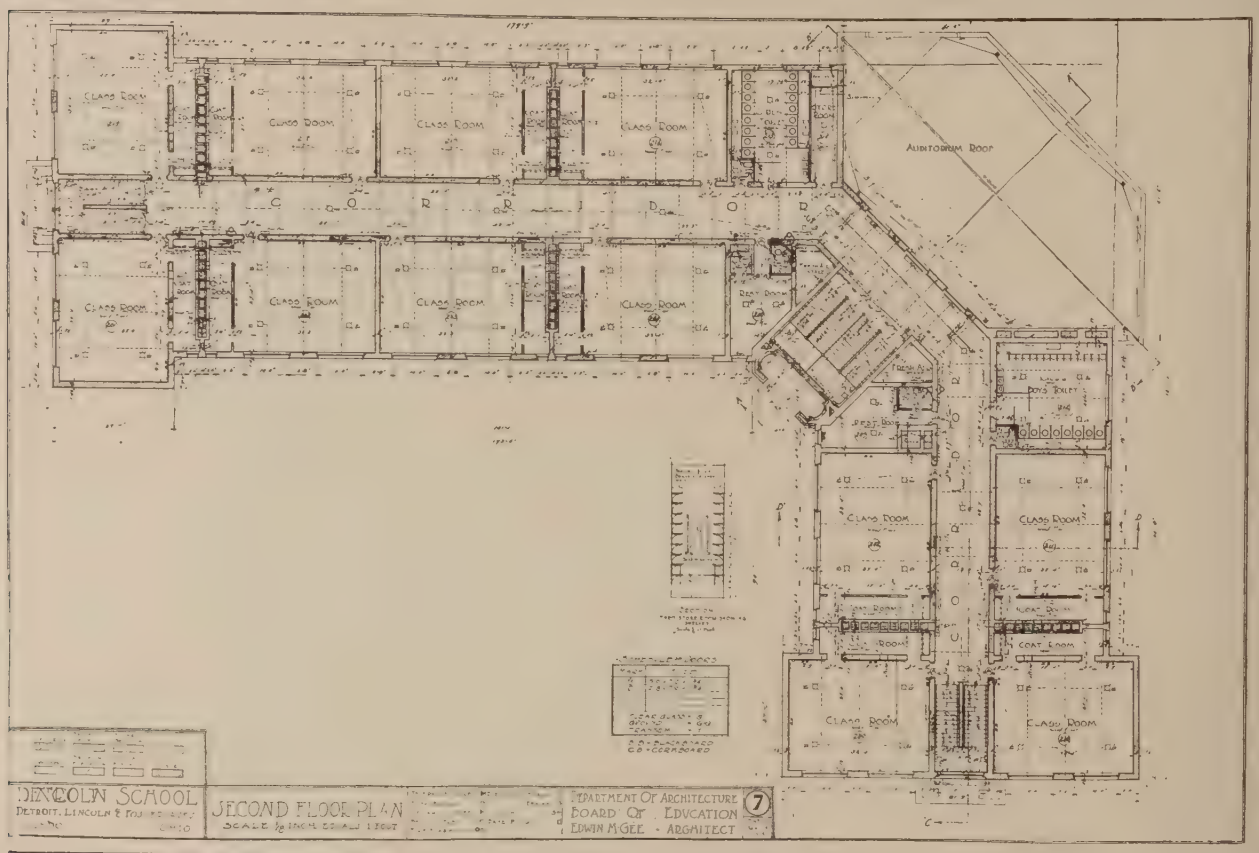
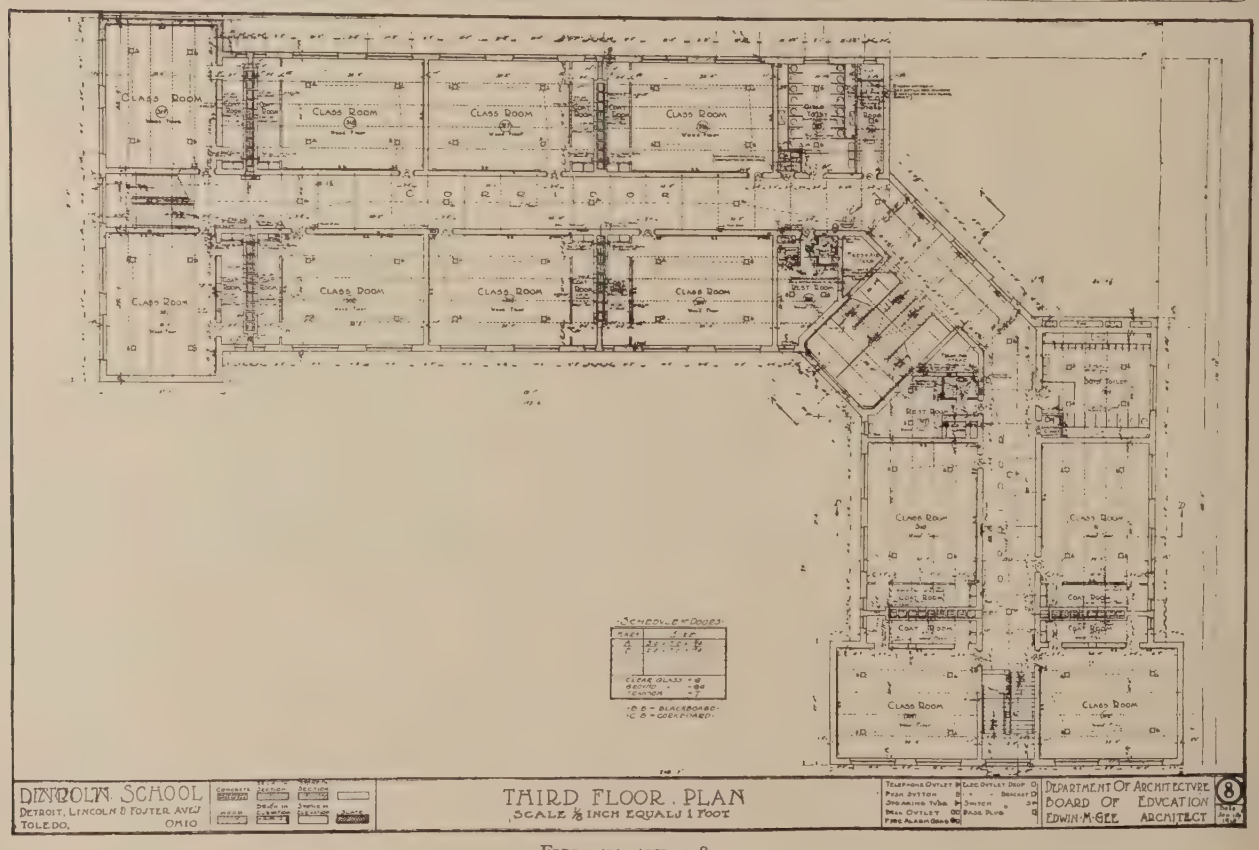

CLASS ROOM
CLASS ROOM
CLASS ROOM
KINDERGARTEN
CLASS ROOM
CORRIDOR
TERRACE
CLASS ROOM
CLASS ROOM
CLASS ROOM
CLASS ROOM
DETROIT AVE
PORTER AVE
LINCOLN SCHOOL
DETROIT · LINCOLN & PORTER AVES
TOLEDO, OHIO
FIRST FLOOR PLAN
SCALE ⅛ INCH EQUALS 1 FT
EDWIN MACEE, ARCHITECT
6

FIG. 516.





FIGS. 517 AND 518.

Mr. Edwin M. Gee, Architect

FIG. 519. — LINCOLN ELEMENTARY SCHOOL, TOLEDO, OHIO.

Mr. William Templeton Johnson, Architect.

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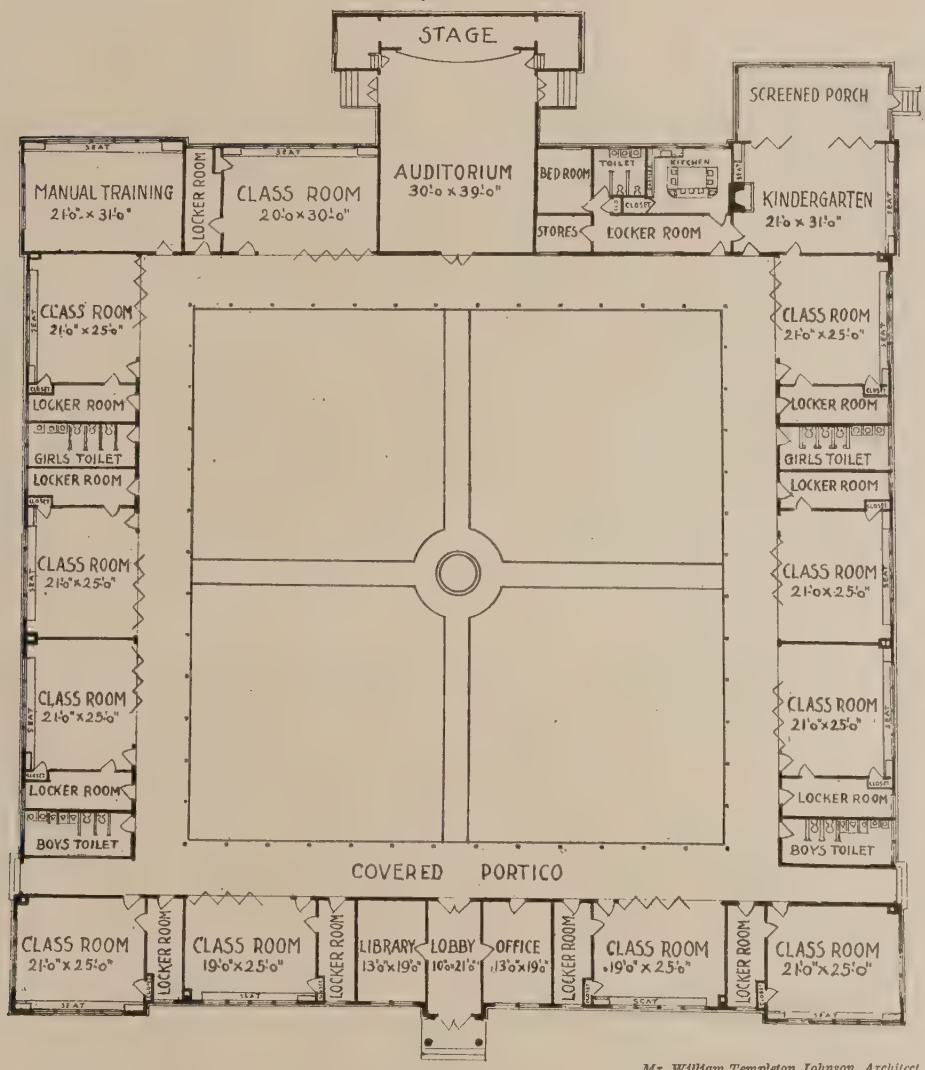
FIG. 520. — FRANCIS W. PARKER SCHOOL, FRONT ELEVATION, SAN DIEGO, CALIFORNIA.



Mr. William Templeton Johnson, Architect

PLAN

SCALE 1/8 IN. = 1 FOOT

FRANCIS W. PARKER SCHOOL,

SAN DIEGO · CAL.

FIG. 521.

Mr. William Templeton Johnson, Architect.

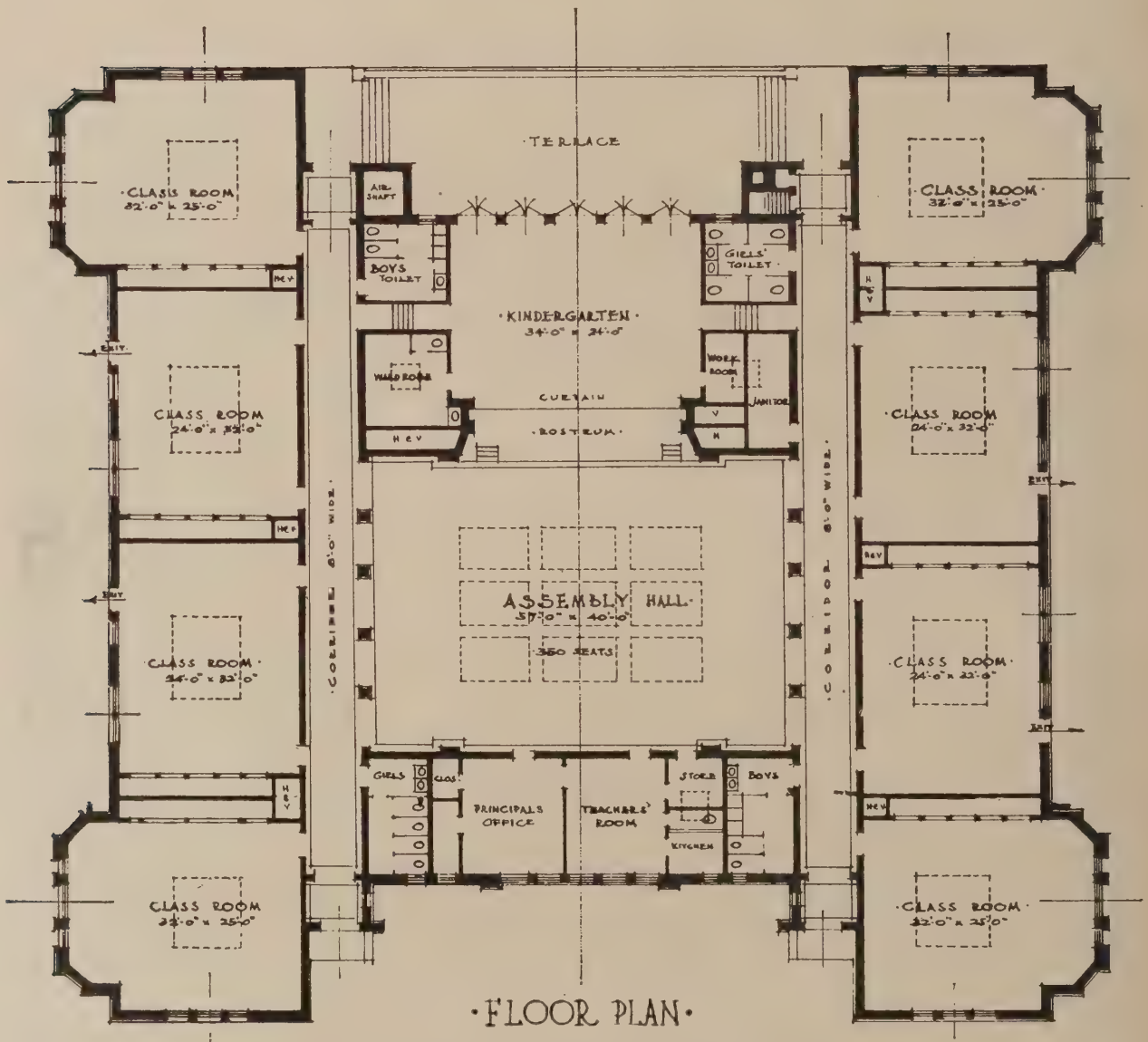
FIG. 522. — FRANCIS W. PARKER SCHOOL, THE PATIO, SAN DIEGO, CALIFORNIA.

Mr. William Templeton Johnson, Architect.

FIG. 523. — FRANCIS W. PARKER SCHOOL, THE PORTICO, SAN DIEGO, CALIFORNIA.

Messrs. Perkins, Fellows, and Hamilton, Architects.

FIG. 524. — LINCOLNWOOD SCHOOL, DISTRICT 75, EVANSTON, ILLINOIS.



·FLOOR PLAN·

·SCHOOL BUILDING · DIST· 75· EVANSTON · ILL·

·COLFAX STREET & Mc DANIEL AVENUE·

·PERKINS · FELLOWS & HAMILTON · ARCHITECTS·

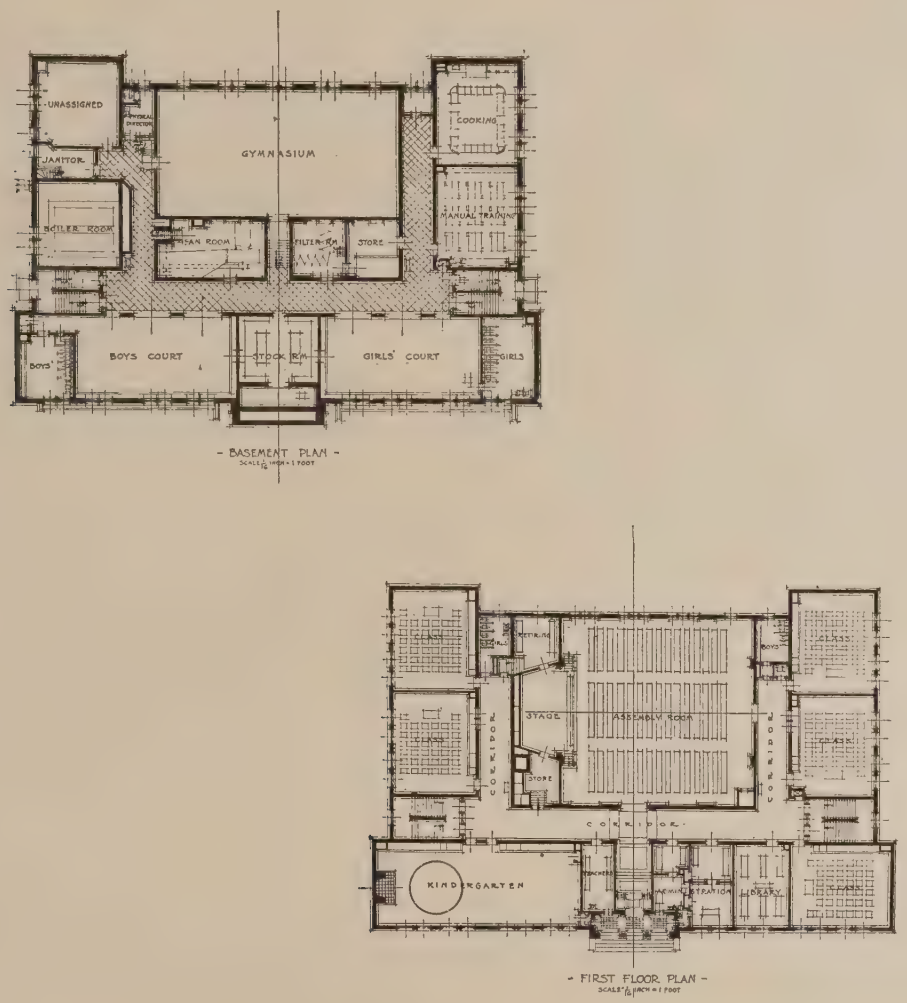
FIG. 525.

Messrs. Guilbert and Betelle, Architects.

FIG. 526. — DETAILS OF DOORWAY, STATE NORMAL SCHOOL, NEWARK, NEW JERSEY.

Messrs. Guilbert and Betelle, Architects.

FIG. 527. — RIDGE SCHOOL, NEWARK, NEW JERSEY.



Messrs. Guilbert and Betelle, Architects.

FIG. 528. — RIDGE SCHOOL, NEWARK, NEW JERSEY.

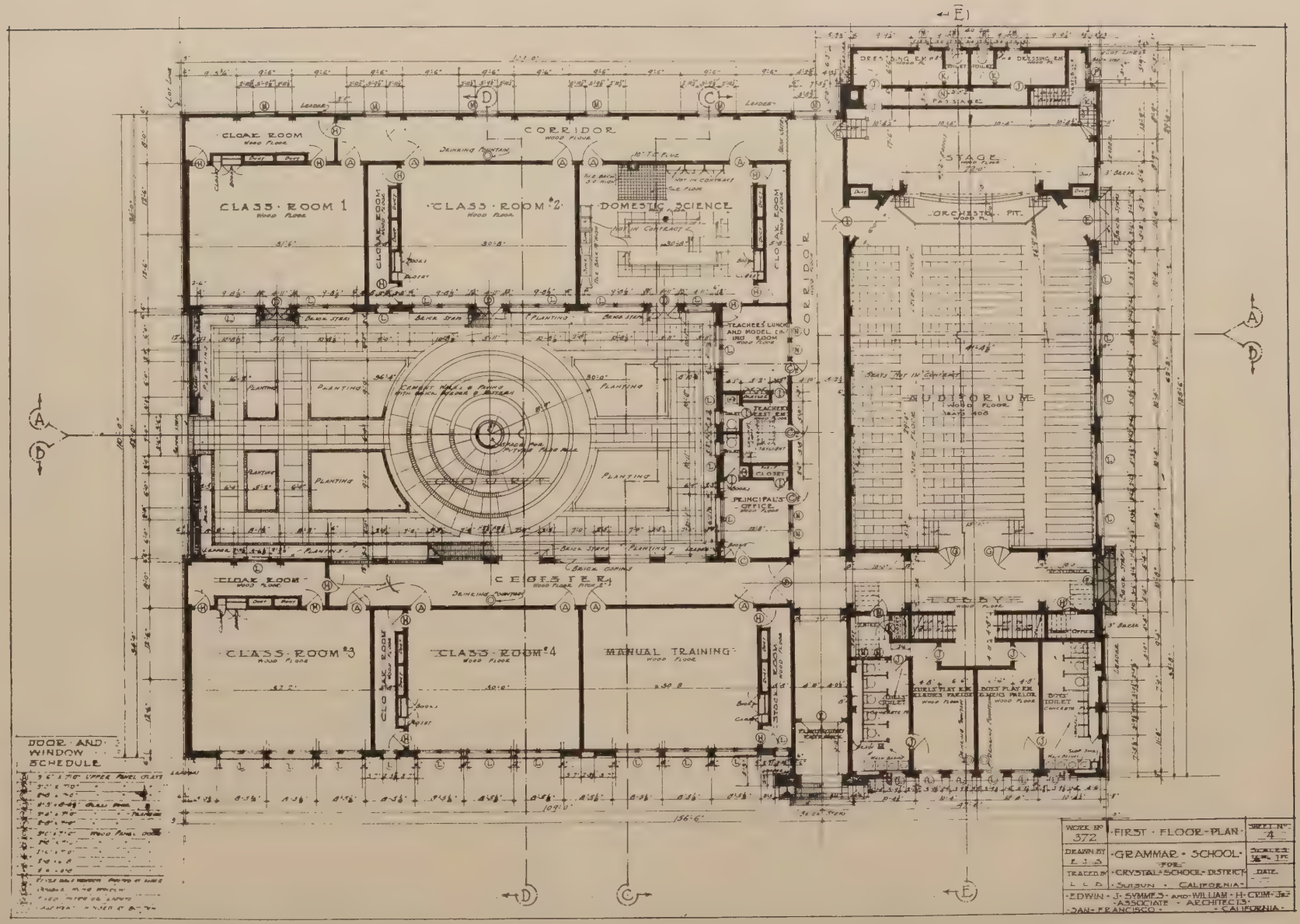
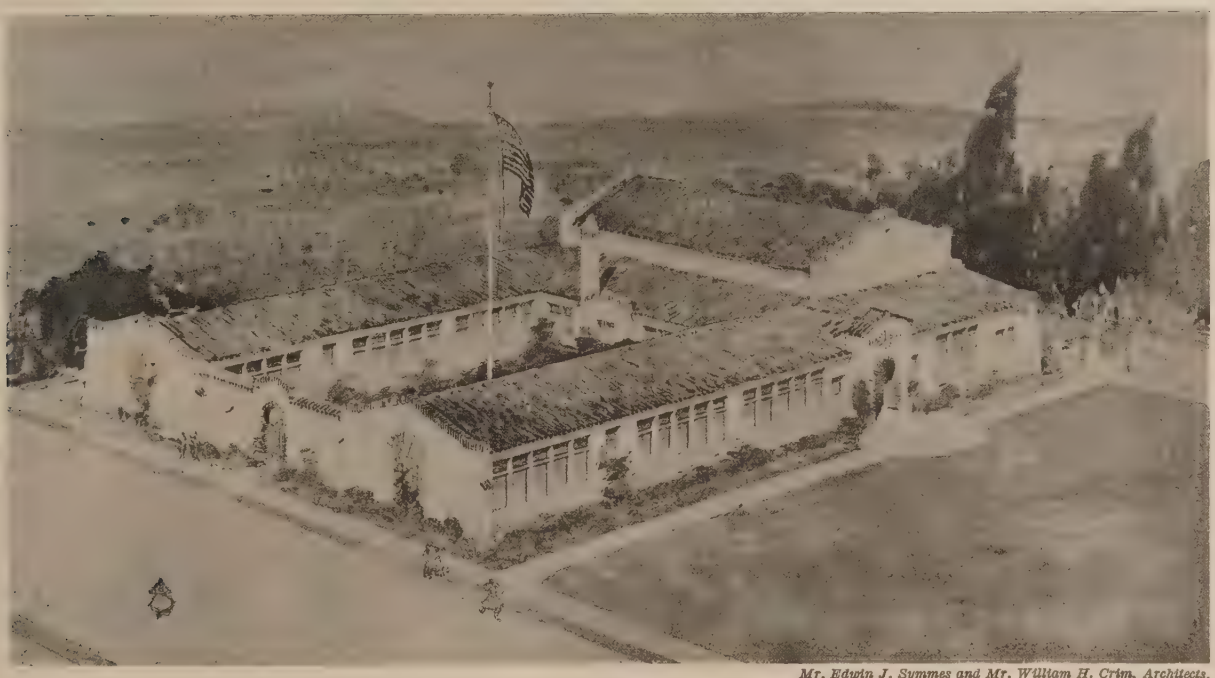

CLOAK ROOM
CORRIDOR
CLASS · ROOM 1
CLASS · ROOM °2
DOMESTIC SCIENCE
CLOAK ROOM
CLOAK ROOM
DRINKING FOUNTAIN
10" T.P. FLUE
TEACHERS LUNCH AND MODEL ROOM
CORRIDOR
STAGE
ORCHESTRA PIT
AUDITORIUM
1400 SEATS
PLANTING
CEMENT WALK & CURB WITH BRICK HEADS & BUTTRESS
COURT
PRINCIPAL'S OFFICE
BRICK COPING
CLOAK ROOM
CLASS · ROOM °3
CLASS · ROOM °4
MANUAL TRAINING
CLOAK ROOM
CLOAK ROOM
STOCK ROOM
LOBBY
GIRLS' PLAY ER
BOYS' PLAY ER
DOOR AND WINDOW SCHEDULE
109'-0"
156'-6"
WORK N° 372
FIRST · FLOOR · PLAN
SHEET N° 4
DRAWN BY E. J. S.
GRAMMAR · SCHOOL · FOR
SCALE 1/8" = 1'-0"
TRACED BY
CRYSTAL SCHOOL DISTRICT
DATE
L. L. D.
SUISUN · CALIFORNIA
EDWIN · J. SYMMES · AND · WILLIAM · H. CRIM · JR°
ASSOCIATE · ARCHITECTS
SAN · FRANCISCO · CALIFORNIA

FIG. 529.

Mr. Edwin J. Symmes and Mr. William H. Crim, Architects.

FIG. 530. — GRAMMAR SCHOOL, CRYSTAL SPRINGS DISTRICT, PATIO, SUISUN, CALIFORNIA.



Mr. Edwin J. Symmes and Mr. William H. Crim, Architects.

FIG. 531. — GRAMMAR SCHOOL, CRYSTAL SPRINGS, PRELIMINARY SKETCH, SUISUN, CALIFORNIA.

Mr. John J. Donovan, Architect, and Mr. Louis C. Mullgardt, Associate Architect.

FIG. 532. — DURANT ELEMENTARY SCHOOL, FRONT ELEVATION, OAKLAND, CALIFORNIA.

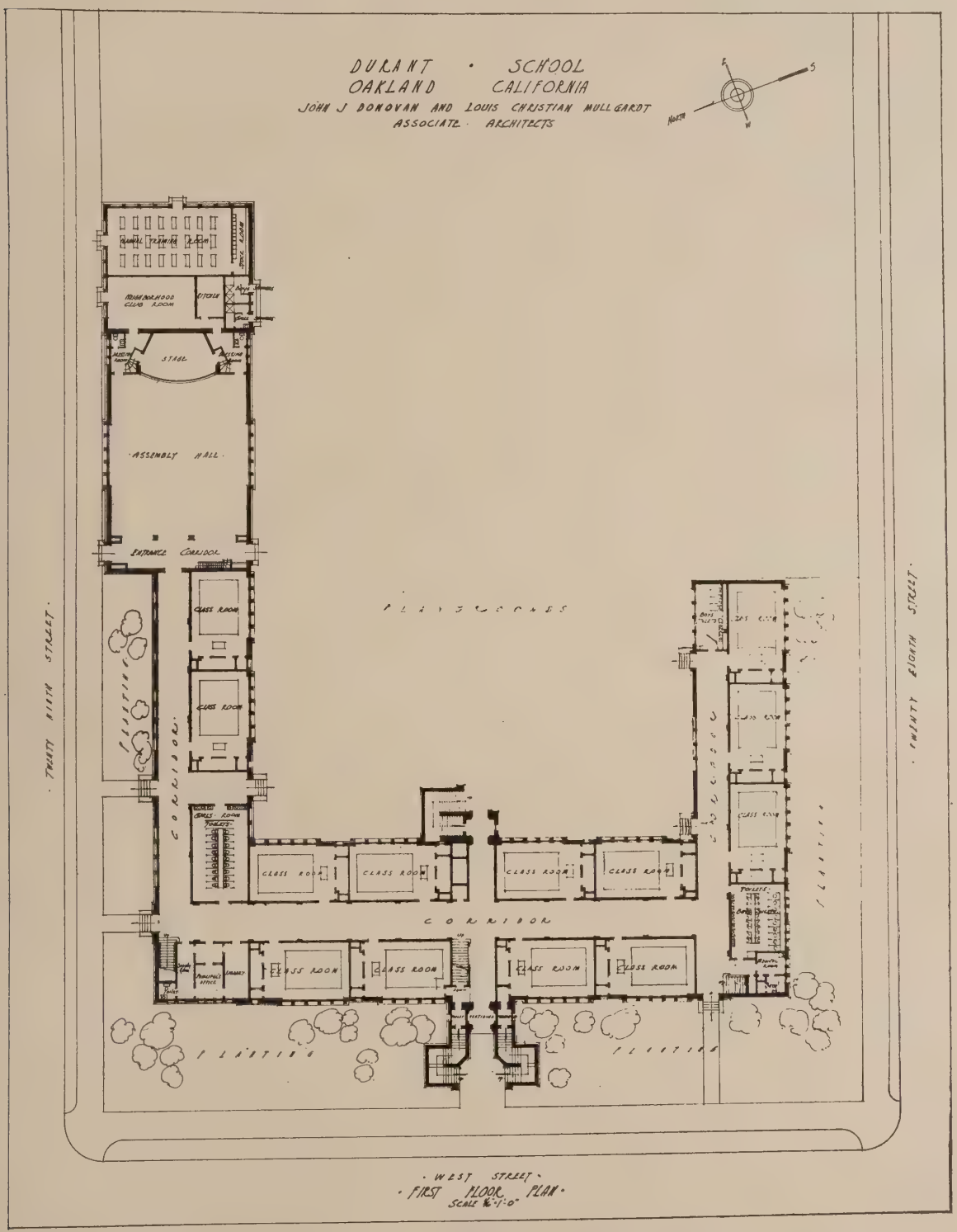

DURANT · SCHOOL
OAKLAND CALIFORNIA
JOHN J BONOVAN AND LOUIS CHRISTIAN MULLGARDT
ASSOCIATE · ARCHITECTS
NEIGHBORHOOD CLUB ROOM
KITCHEN
STAGE
ASSEMBLY HALL
ENTRANCE CORRIDOR
CLASS ROOM
CLASS ROOM
CORRIDOR
SHOP
SEWING ROOM
TOILETS
CLASS ROOM
CLASS ROOM
CLASS ROOM
CLASS ROOM
CORRIDOR
CLASS ROOM
CLASS ROOM
CLASS ROOM
CLASS ROOM
CLASS ROOM
TOILETS
PLANTING
PLANTING
PLANTING
PLANTING
PLAYGROUNDS
· THIRTY NINTH STREET ·
· TWENTY EIGHTH STREET ·
· WEST STREET ·
· FIRST FLOOR PLAN ·
SCALE 1/8"-1'-0"

FIG. 533.

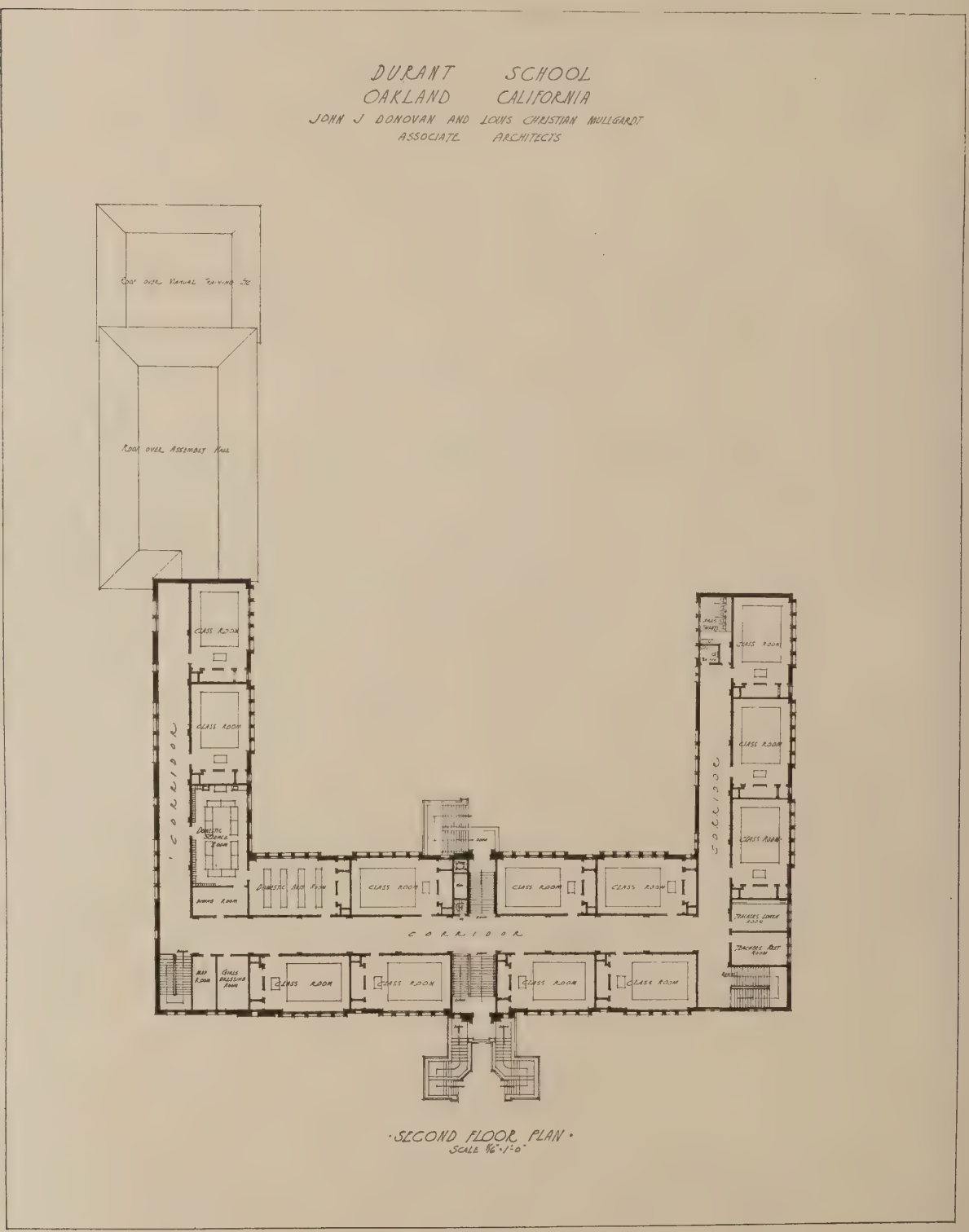
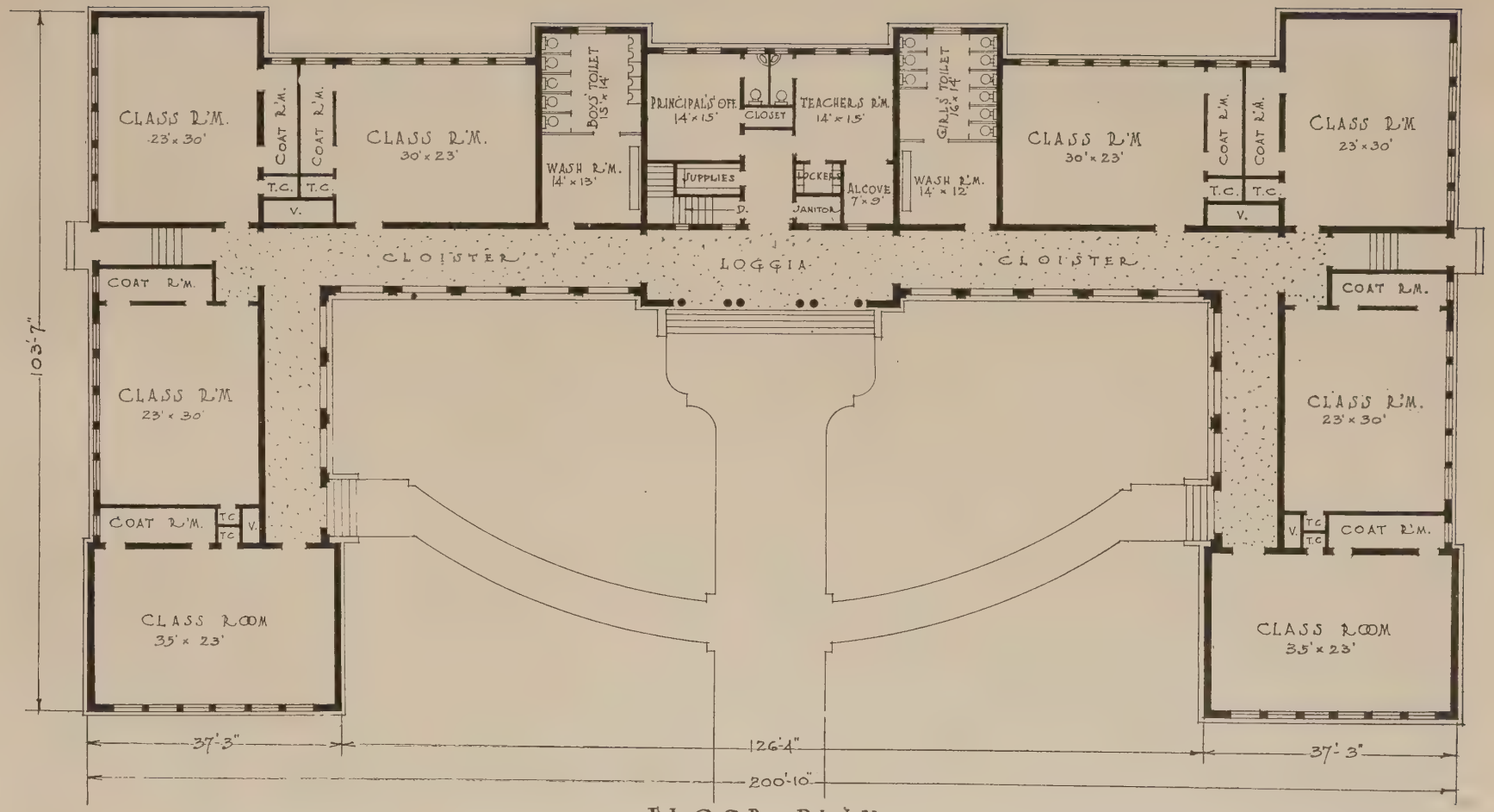

DURANT SCHOOL
OAKLAND CALIFORNIA
JOHN J DONOVAN AND LOUIS CHRISTIAN MULLGARDT
ASSOCIATE ARCHITECTS
ROOF OVER ASSEMBLY HALL
CLASS ROOM
CORRIDOR
DOMESTIC SCIENCE ROOM
DOMESTIC ART ROOM
BOYS TOILET
GIRLS TOILET
TEACHERS TOILET
TEACHERS REST ROOM
SECOND FLOOR PLAN
SCALE 1/8"-1'-0"

FIG. 534.



FLOOR PLAN
SCALE 1"= 16 FT.

GRAMMAR SCHOOL
GLENDORA CAL
ALLISON & ALLISON - ARCHITECTS
LOS ANGELES

FIG. 535.

Fig. 536.

Fig. 537.

Fig. 538.

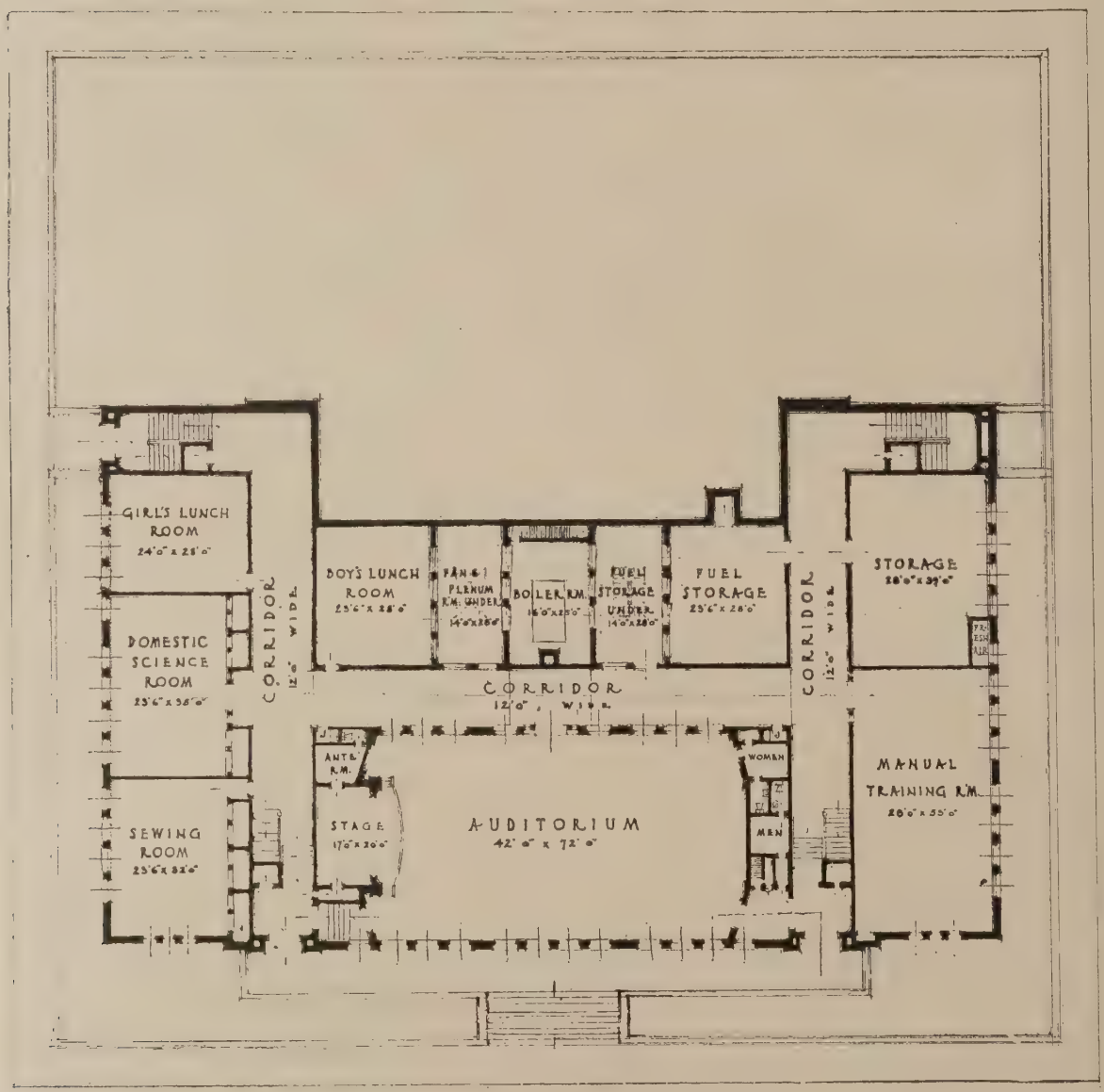
Fig. 539.

Grammar School, Glendora, California.

Messrs. Allison and Allison, Architects.

FIG. 540. — CENTRAL GRAMMAR SCHOOL, ASTORIA, OREGON.

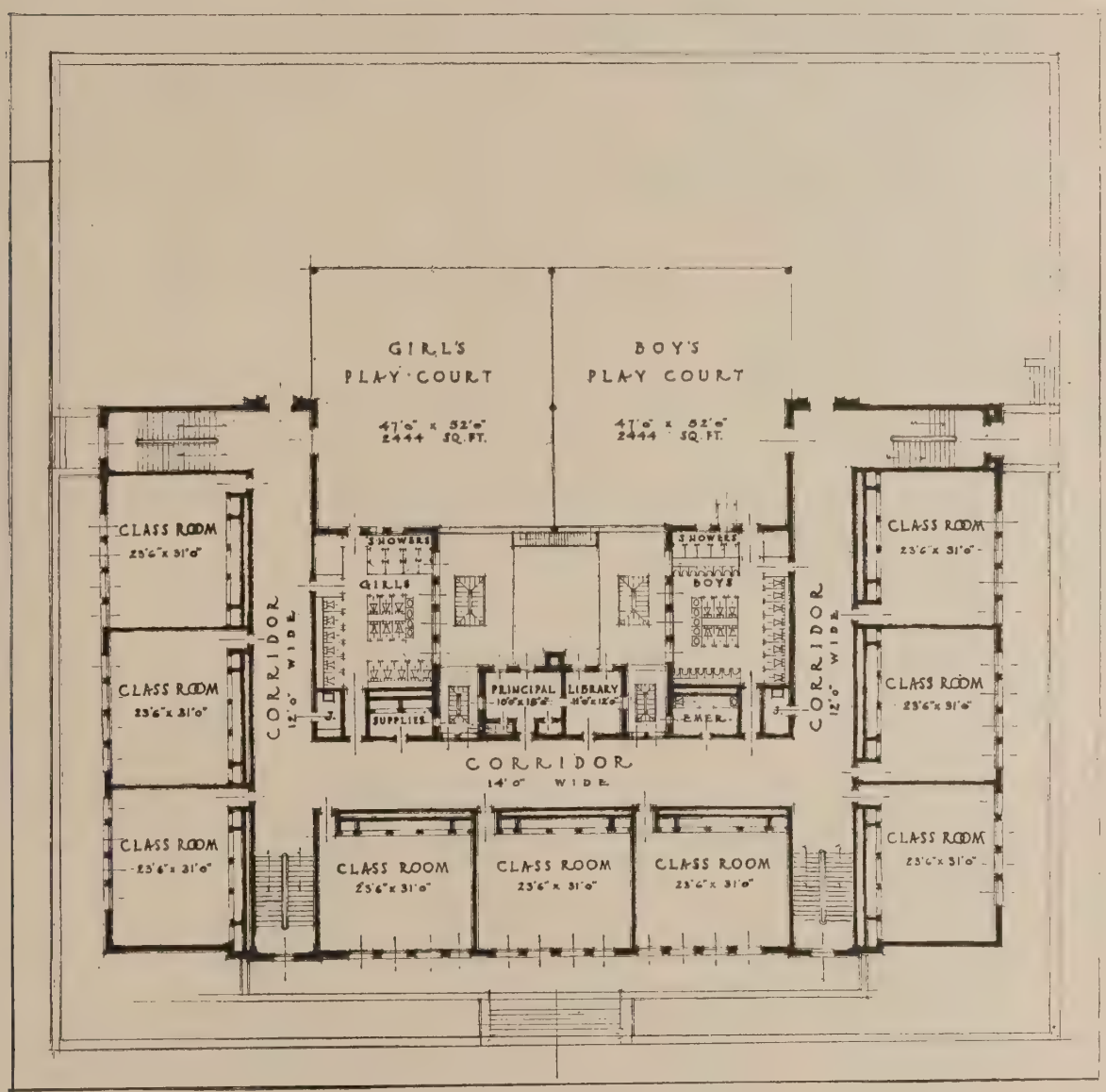
Messrs. Whitehouse and Foulhaux, Architects.



'GROUND 'FLOOR 'PLAN'

Messrs. Whitehouse and Foulhaux, Architects.

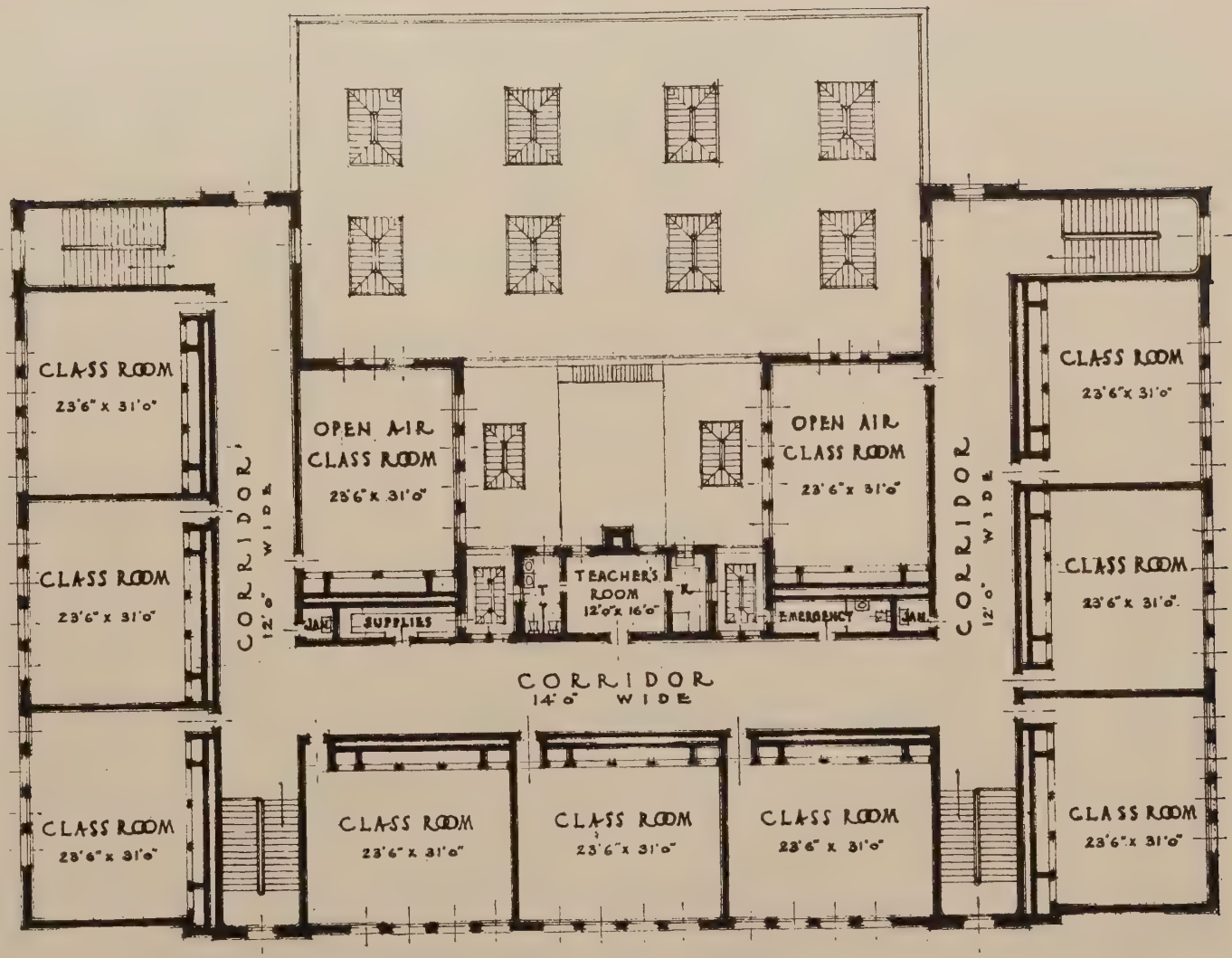
FIG. 541. — CENTRAL GRAMMAR SCHOOL, GROUND FLOOR PLAN, ASTORIA, OREGON.



FIRST FLOOR PLAN

Messrs. Whitehouse and Foulhaux, Architects

FIG. 542. — CENTRAL GRAMMAR SCHOOL, FIRST FLOOR PLAN, ASTORIA, OREGON.



SECOND FLOOR PLAN

Messrs. Whitehouse and Fouilhaux, Architects.

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FIG. 543. — CENTRAL GRAMMAR SCHOOL, SECOND FLOOR PLAN, ASTORIA, OREGON.

Mr. Edwin M. Gee, Architect.

FIG. 544. — MOTT SCHOOL, TOLEDO, OHIO.

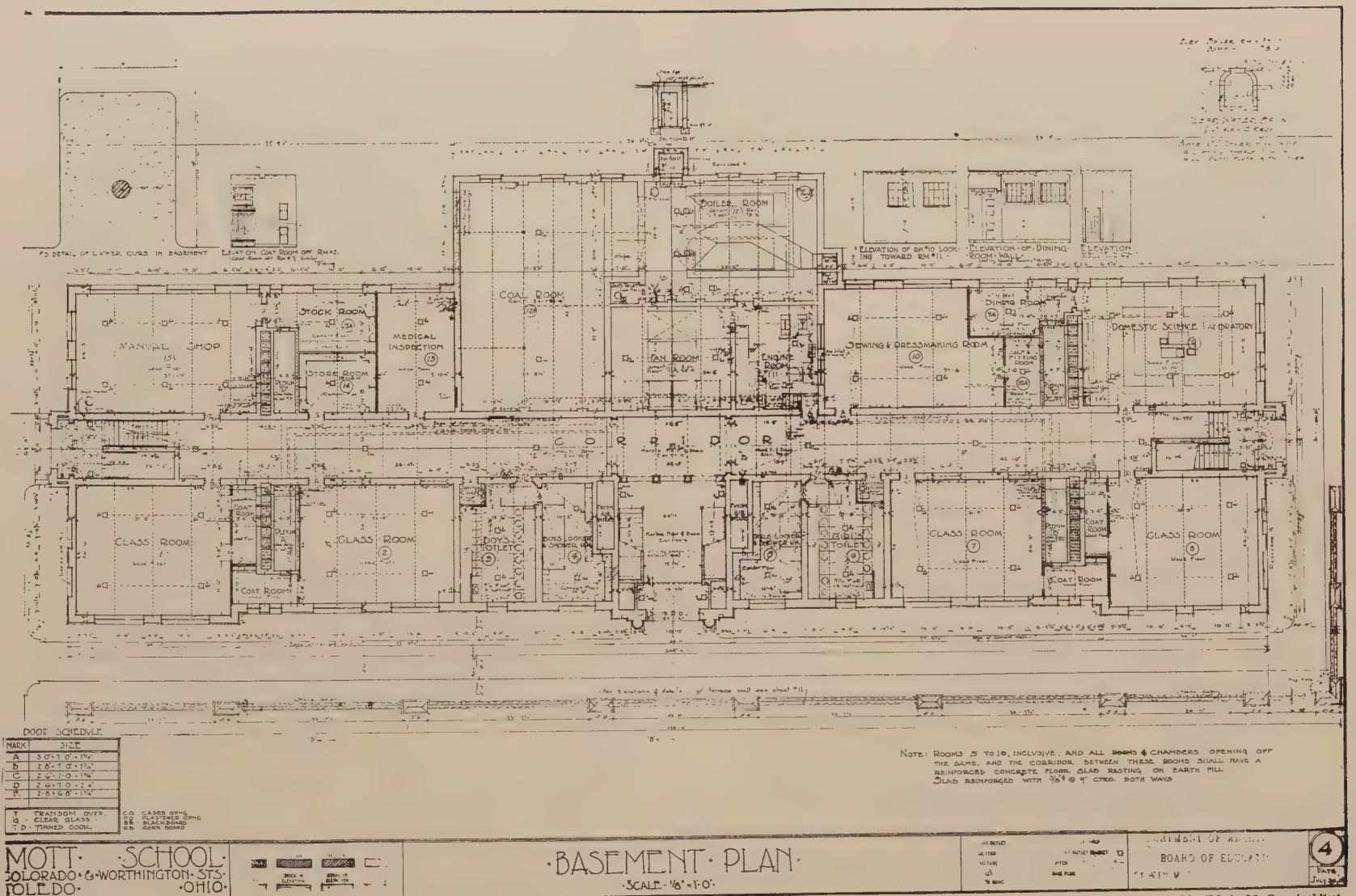
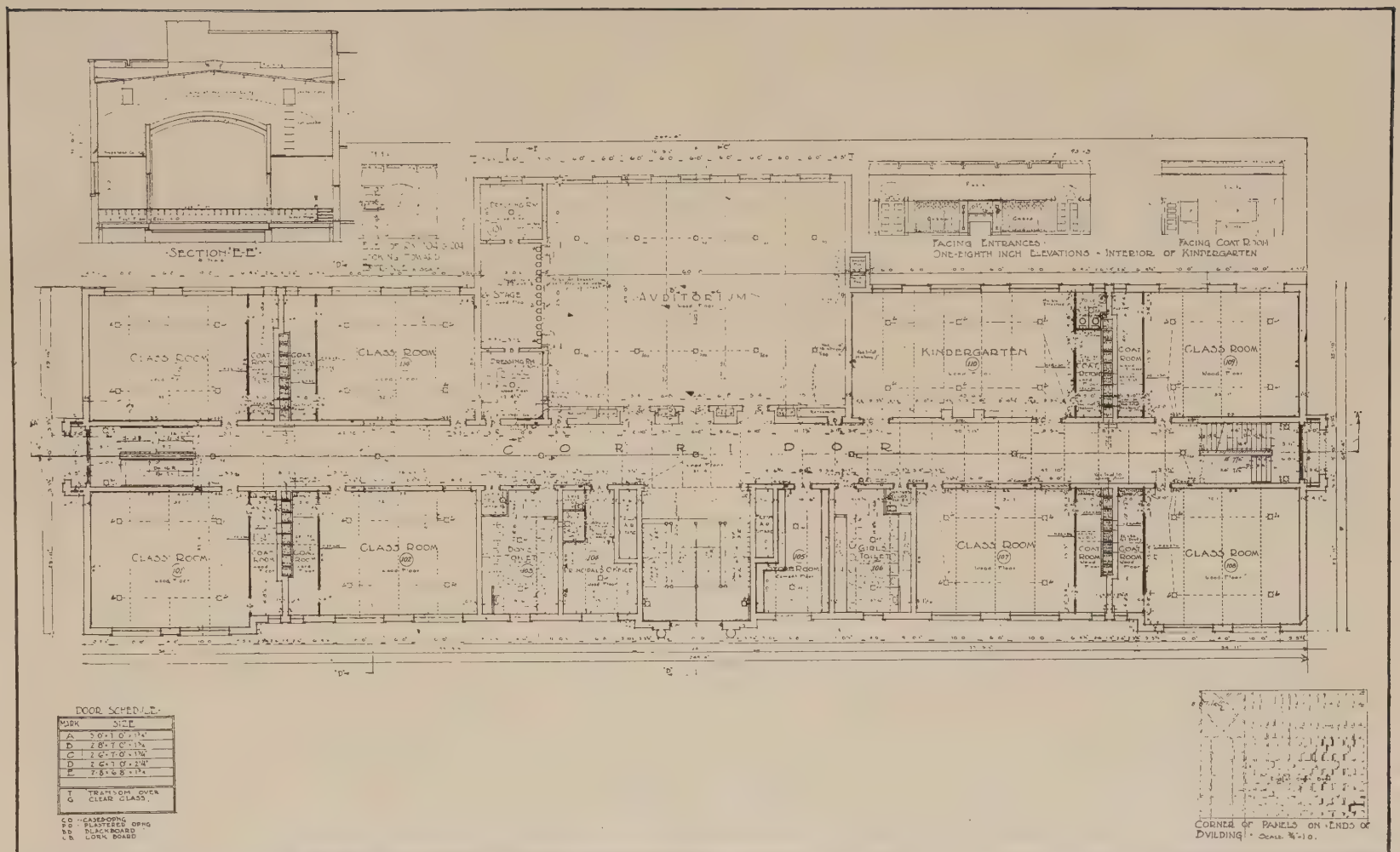

BOILER ROOM
COAL ROOM
STOCK ROOM
MANUAL SHOP
MEDICAL INSPECTION
STORE ROOM
FAN ROOM
ENGINE ROOM
SEWING & DRESSMAKING ROOM
DINING ROOM
DOMESTIC SCIENCE LABORATORY
CLASS ROOM
CLASS ROOM
GIRLS TOILET
BOYS TOILET
CLASS ROOM
CLASS ROOM
COAT ROOM
COAT ROOM
CORRIDOR
ELEVATION OF RM 10 LOOKING TOWARD RM 11
ELEVATION OF DINING ROOM WALL
ELEVATION
ELEVATION COAT ROOM OFF RM 12
TO DETAIL OF LAYER CURB IN BASEMENT
DOOR SCHEDULE
MARK SIZE
A 3'0"x7'0"x1¾"
B 2'8"x7'0"x1¾"
C 2'6"x7'0"x1¾"
D 2'4"x7'0"x1¾"
E 2'8"x6'0"x1¾"
T TRANSOM OVER
G - CLEAR GLASS
T D - TINNED DOOR
CO CASED OPNG
PO PLASTERED OPNG
BB - BLACKBOARD
CB CORK BOARD
NOTE: ROOMS 5 TO 10, INCLUSIVE, AND ALL ROOMS & CHAMBERS OPENING OFF THE SAME, AND THE CORRIDOR BETWEEN THESE ROOMS SHALL HAVE A REINFORCED CONCRETE FLOOR SLAB RESTING ON EARTH FILL.
SLAB REINFORCED WITH ⅜ø @ 9" CTRS. BOTH WAYS
MOTT SCHOOL
COLORADO & WORTHINGTON STS.
TOLEDO OHIO
BASEMENT PLAN
SCALE 1/8"=1'-0"
BOARD OF EDUCATION
4
DATE
Mr. Edwin M. Gee, Architect.

FIG. 545.



MOTT · SCHOOL
COLORADO & WORTHINGTON STS.
TOLEDO · OHIO

FIRST FLOOR PLAN

SCALE 1/8" = 1'-0"

DEPARTMENT OF ARCHITECTURE
BOARD OF EDUCATION
EDWIN H. GEE · ARCHITECT

6

FIG. 546.

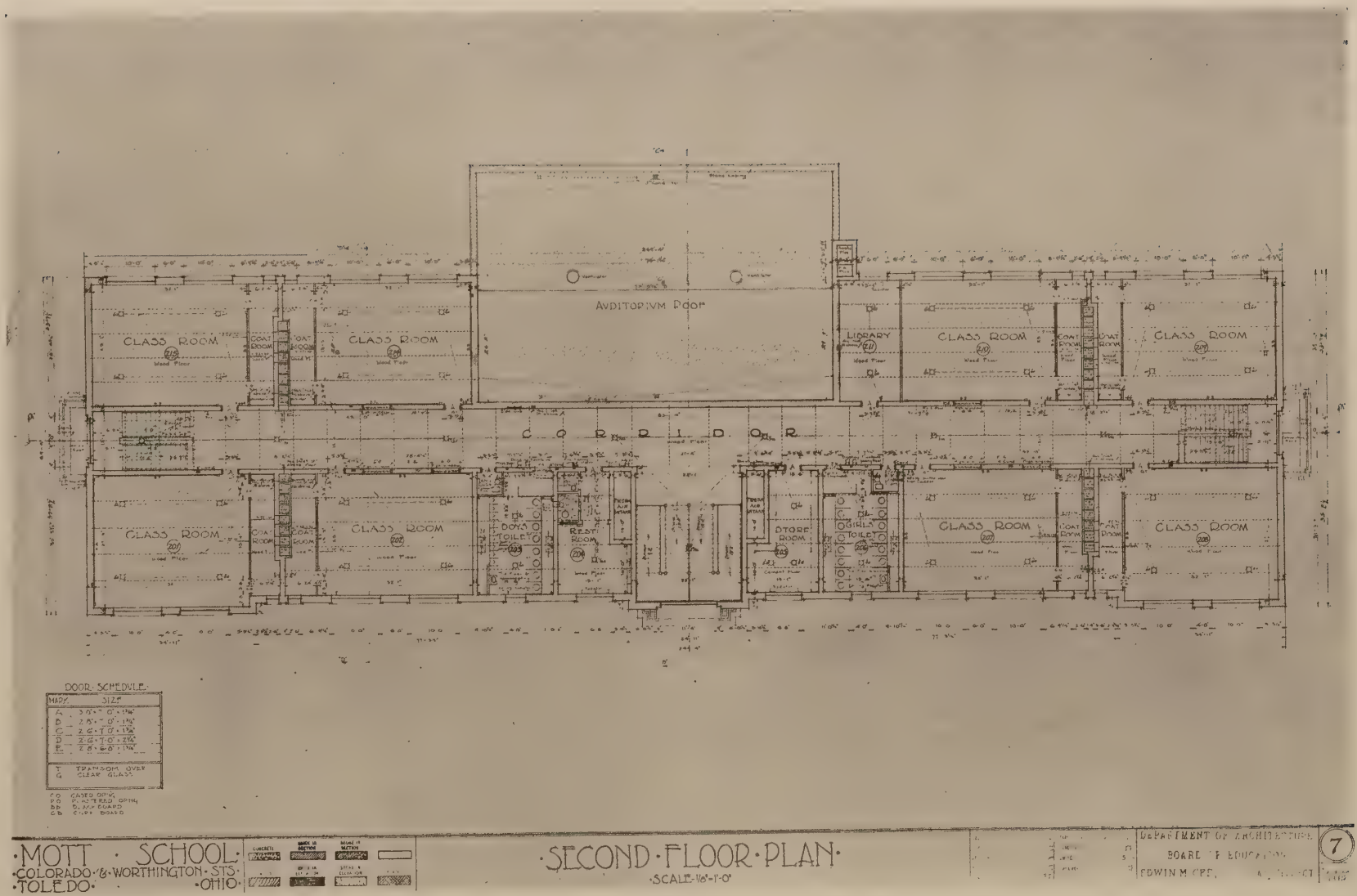

AUDITORIUM Floor
CLASS ROOM
CLASS ROOM
LIBRARY
CLASS ROOM
CLASS ROOM
CORRIDOR
CLASS ROOM
CLASS ROOM
BOYS TOILET
REST ROOM
STORE ROOM
GIRLS TOILET
CLASS ROOM
CLASS ROOM
DOOR SCHEDULE
MARK
SIZE
TRANSOM OVER
CLEAR GLASS
MOTT · SCHOOL
COLORADO & WORTHINGTON STS.
TOLEDO · OHIO
SECOND FLOOR PLAN
SCALE 1/8"-1'-0"
DEPARTMENT OF ARCHITECTURE
BOARD OF EDUCATION
EDWIN M. CPE
7

FIG. 547.

Messrs. Kilham and Hopkins, Architects.

FIG. 548. — SCHOOLHOUSE, ATLANTIC HEIGHTS, NEW HAMPSHIRE.

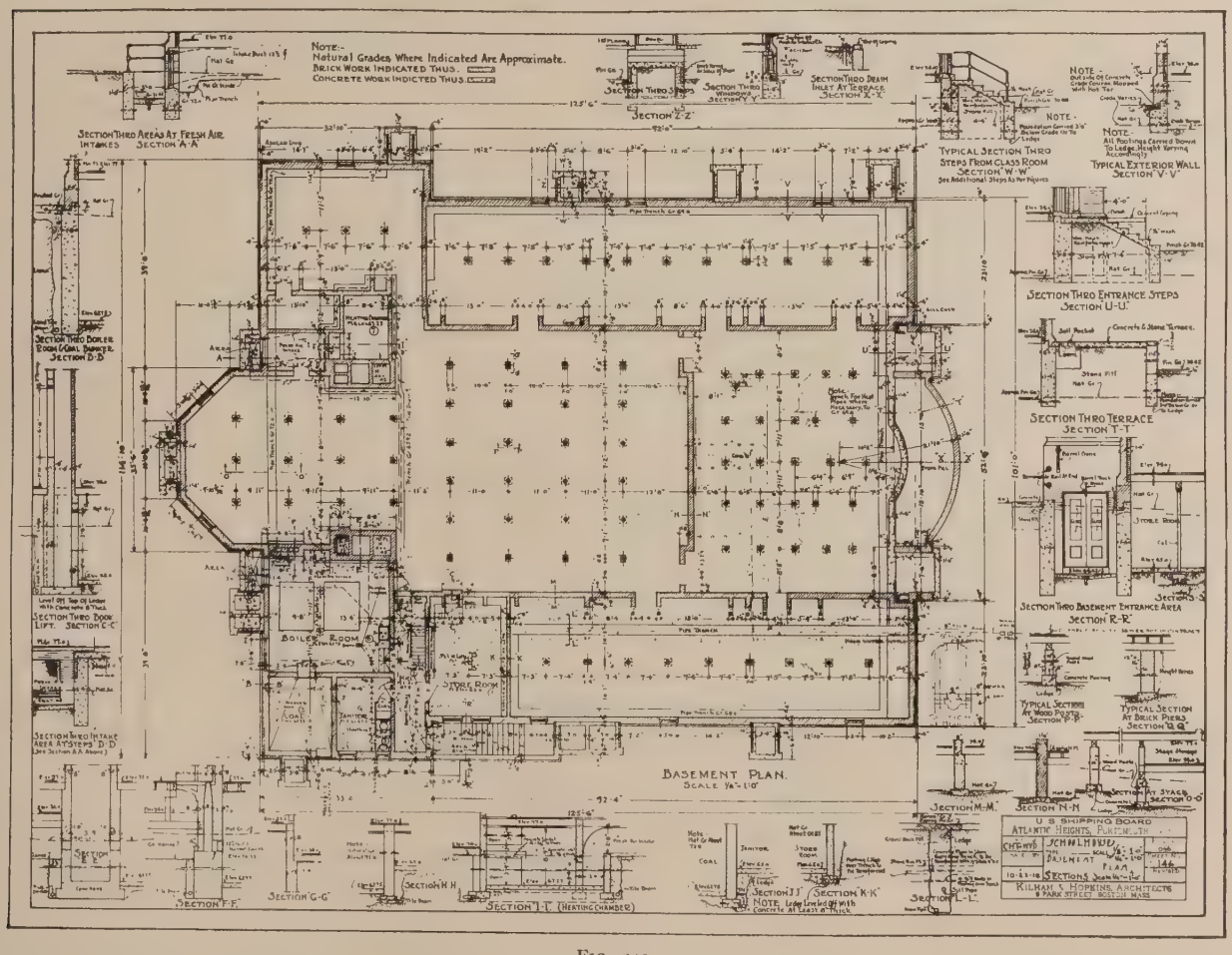
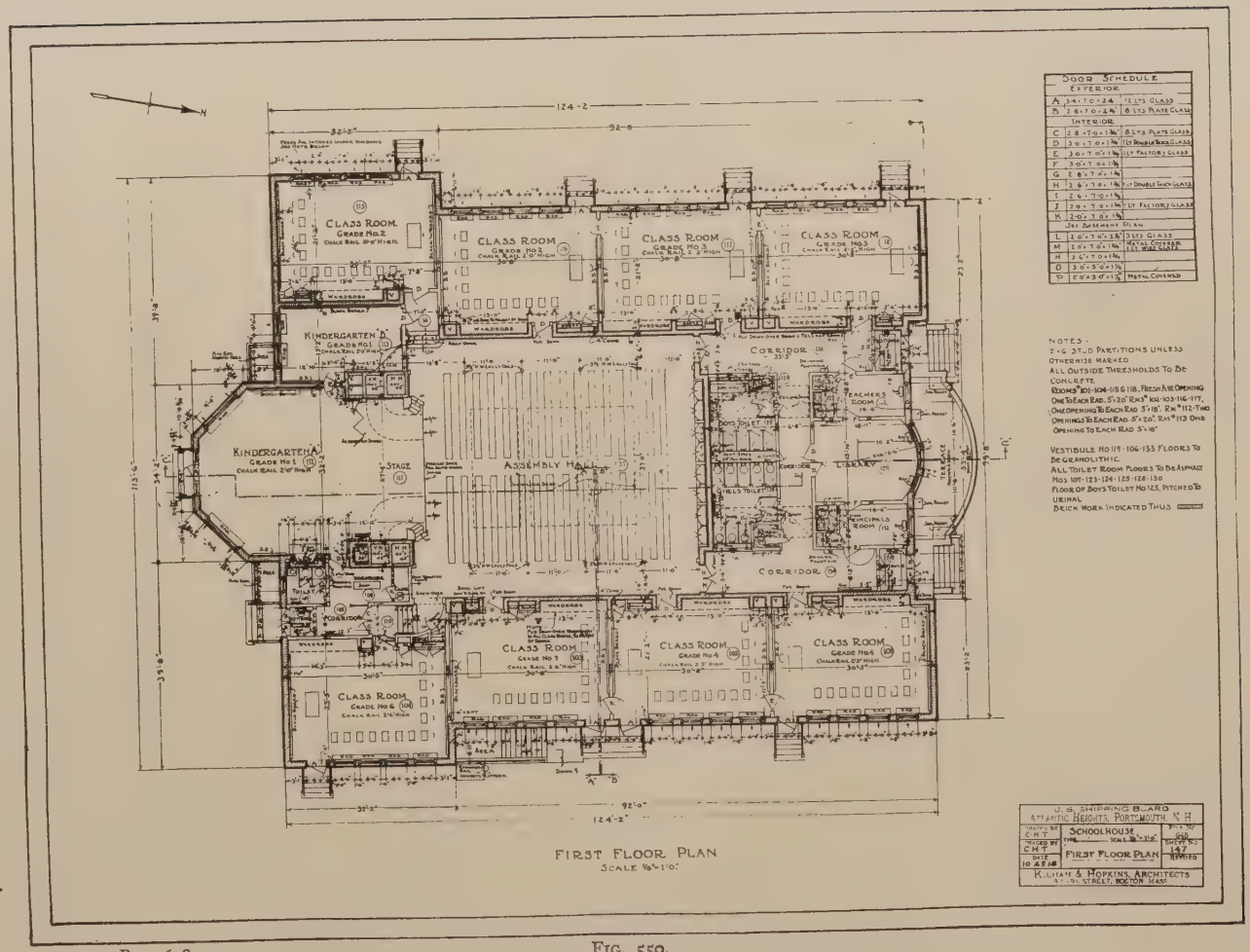


FIG. 549.


CLASS ROOM GRADE No 2
CLASS ROOM GRADE No 3
CLASS ROOM GRADE No 3
CLASS ROOM GRADE No 3
KINDERGARTEN GRADE No 1
KINDERGARTEN GRADE No 1
ASSEMBLY HALL
STAGE
CORRIDOR
TEACHERS ROOM
BOYS TOILET
GIRLS TOILET
PRINCIPALS ROOM
CORRIDOR
CLASS ROOM GRADE No 5
CLASS ROOM GRADE No 4
CLASS ROOM GRADE No 4
CLASS ROOM GRADE No 6
124'-2"
92'-0"
DOOR SCHEDULE
EXTERIOR
INTERIOR
1st BASEMENT PLAN
NOTES:-
2"-6" STUD PARTITIONS UNLESS OTHERWISE MARKED
ALL OUTSIDE THRESHOLDS TO BE CONCRETE
ROOMS 101-104-115 & 118, FRESH AIR OPENING ONE TO EACH RAD. 5'-20" RMS 102-103-116-117, ONE OPENING TO EACH RAD 3'-18". RM 112-TWO OPENINGS TO EACH RAD. 5'-20". RM 113 ONE OPENING TO EACH RAD 5'-18"
VESTIBULE NO 119-106-133 FLOORS TO BE GRANOLITHIC
ALL TOILET ROOM FLOORS TO BE ASPHALT NOS 101-123-124-125-128-130
FLOOR OF BOYS TOILET NO 125, PITCHED TO URINAL
BRICK WORK INDICATED THUS
U. S. SHIPPING BOARD
ATLANTIC HEIGHTS, PORTSMOUTH, N.H.
SCHOOLHOUSE
FIRST FLOOR PLAN
KILHAM & HOPKINS, ARCHITECTS
10 PARK STREET, BOSTON, MASS.

FIRST FLOOR PLAN
SCALE 1/8"=1'-0"

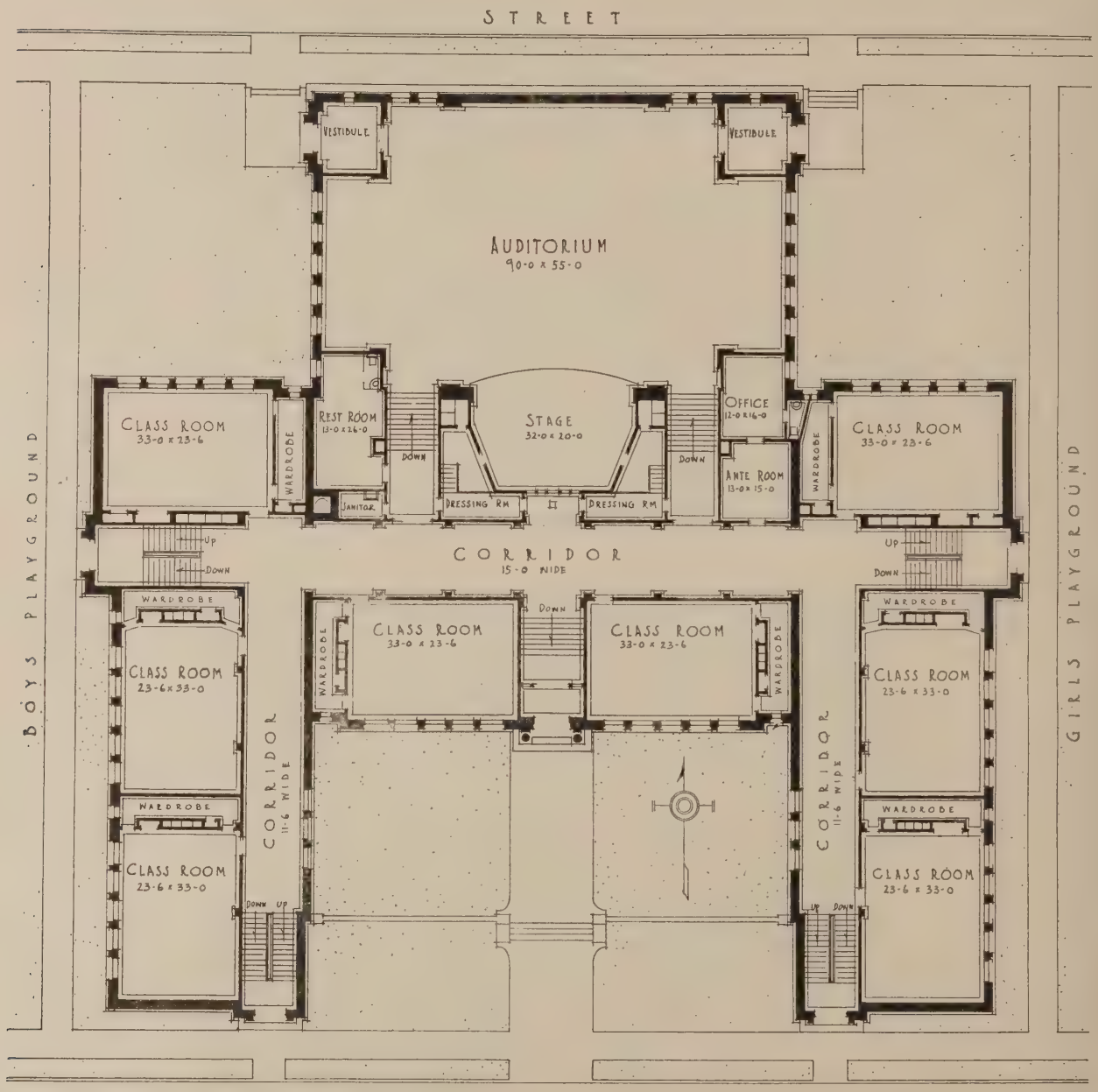
FIG. 550.

Messrs. Lawrence and Holford, Architects.

Page 619 FIG. 551. — FERNWOOD SCHOOL, PORTLAND, OREGON.

Messrs. Lawrence and Holford, Architects.

FIG. 552. — FERNWOOD SCHOOL, PORTLAND, OREGON.

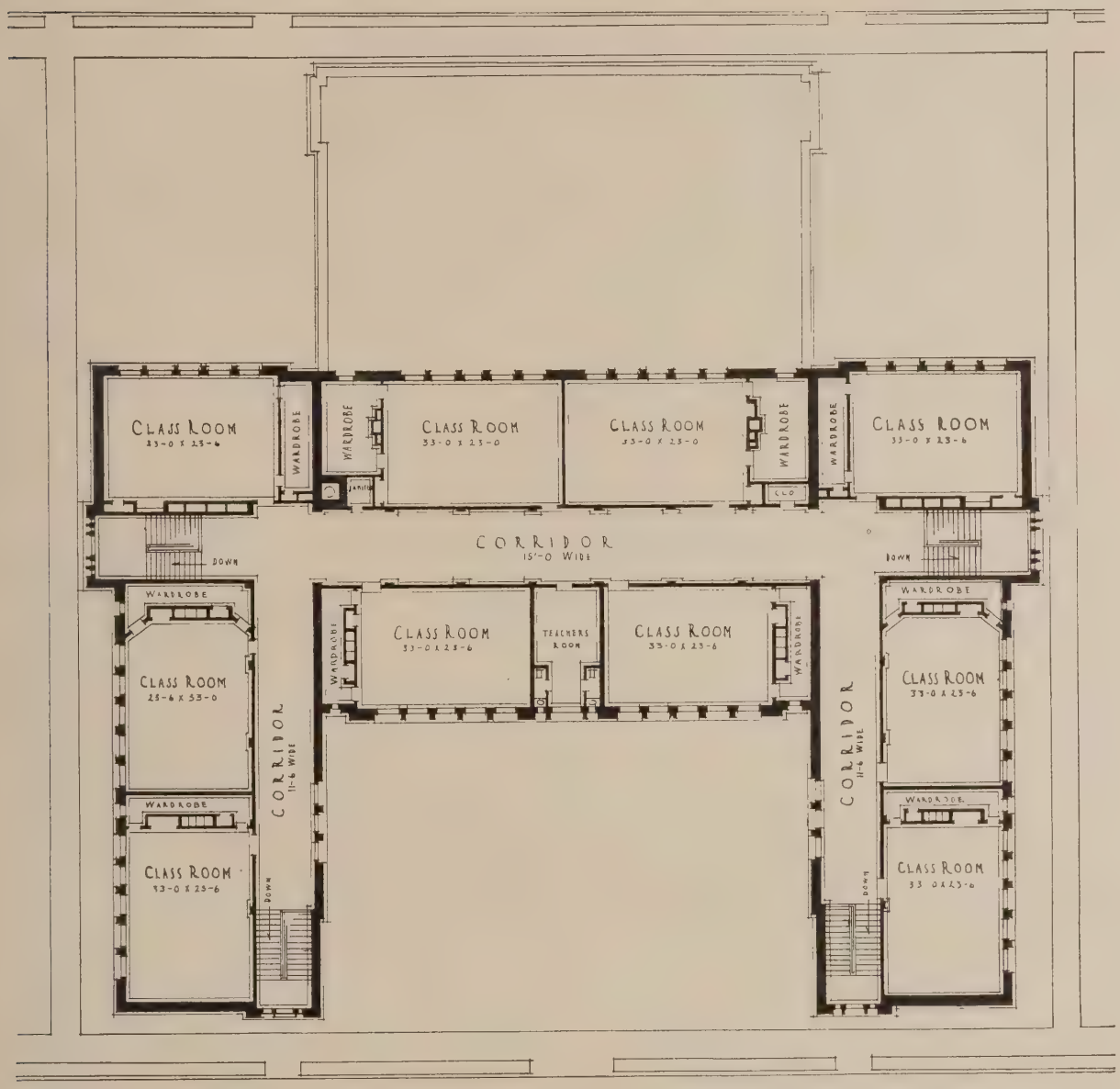


FIRST FLOOR PLAN

FERNWOOD GRAMMAR SCHOOL · PORTLAND · OR.

Messrs. Lawrence and Holford, Architects.

FIG. 553.

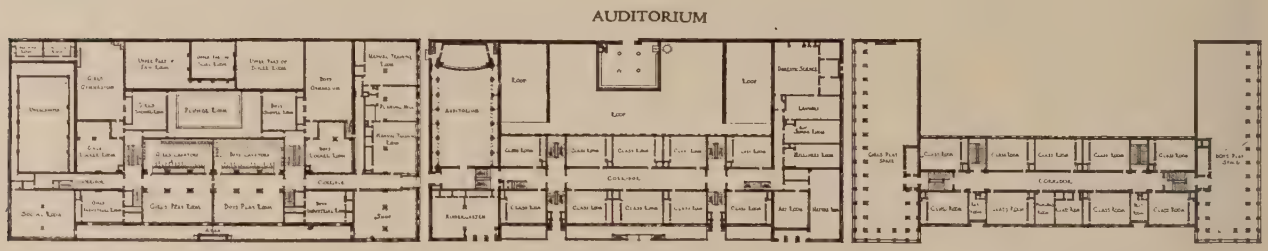


SECOND FLOOR PLAN

FERNWOOD GRAMMAR SCHOOL · PORTLAND · OR

Messrs. Lawrence and Holford, Architects.

FIG. 554.



Messrs. Garber and Woodward, Architects.

FIG. 555. — LAFAYETTE BLOOM SCHOOL, CINCINNATI, OHIO.

Messrs. Garber and Woodward, Architects.

FIG. 556. — LAFAYETTE BLOOM SCHOOL, AUDITORIUM, CINCINNATI, OHIO.

Messrs. Garber and Woodward, Architects.

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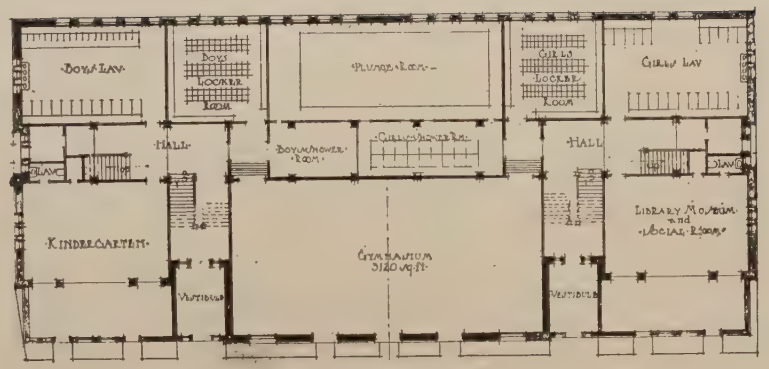
FIG. 557. — LAFAYETTE BLOOM SCHOOL, CINCINNATI, OHIO.

Messrs. Garber and Woodward, Architects.

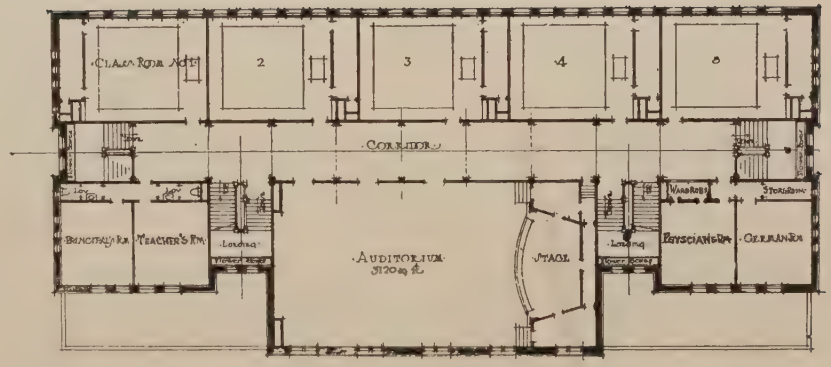
FIG. 558. — GUILFORD SCHOOL, CINCINNATI, OHIO.

Messrs. Garber and Woodward, Architects.

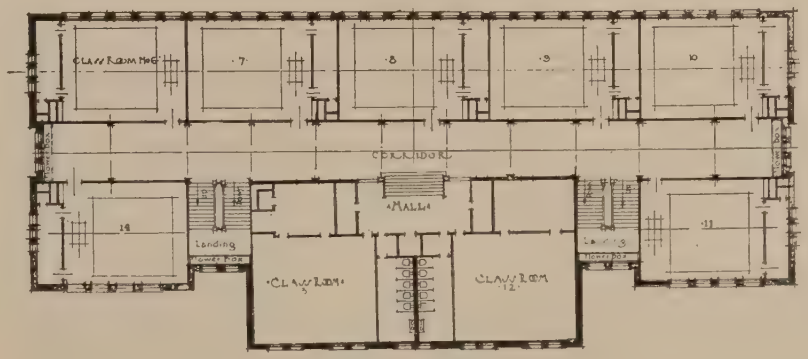
FIG. 559. — GUILFORD SCHOOL, CINCINNATI, OHIO.



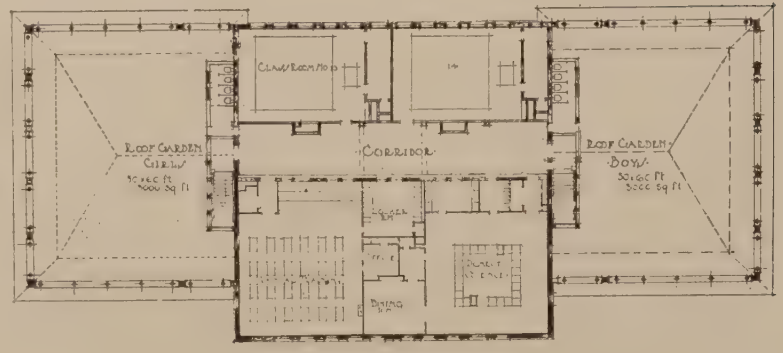
GROUND FLOOR PLAN



FIRST FLOOR PLAN



SECOND FLOOR PLAN



THIRD FLOOR PLAN

Messrs. Garber and Woodward, Architects.

FIG. 560. — GUILFORD SCHOOL, CINCINNATI, OHIO.

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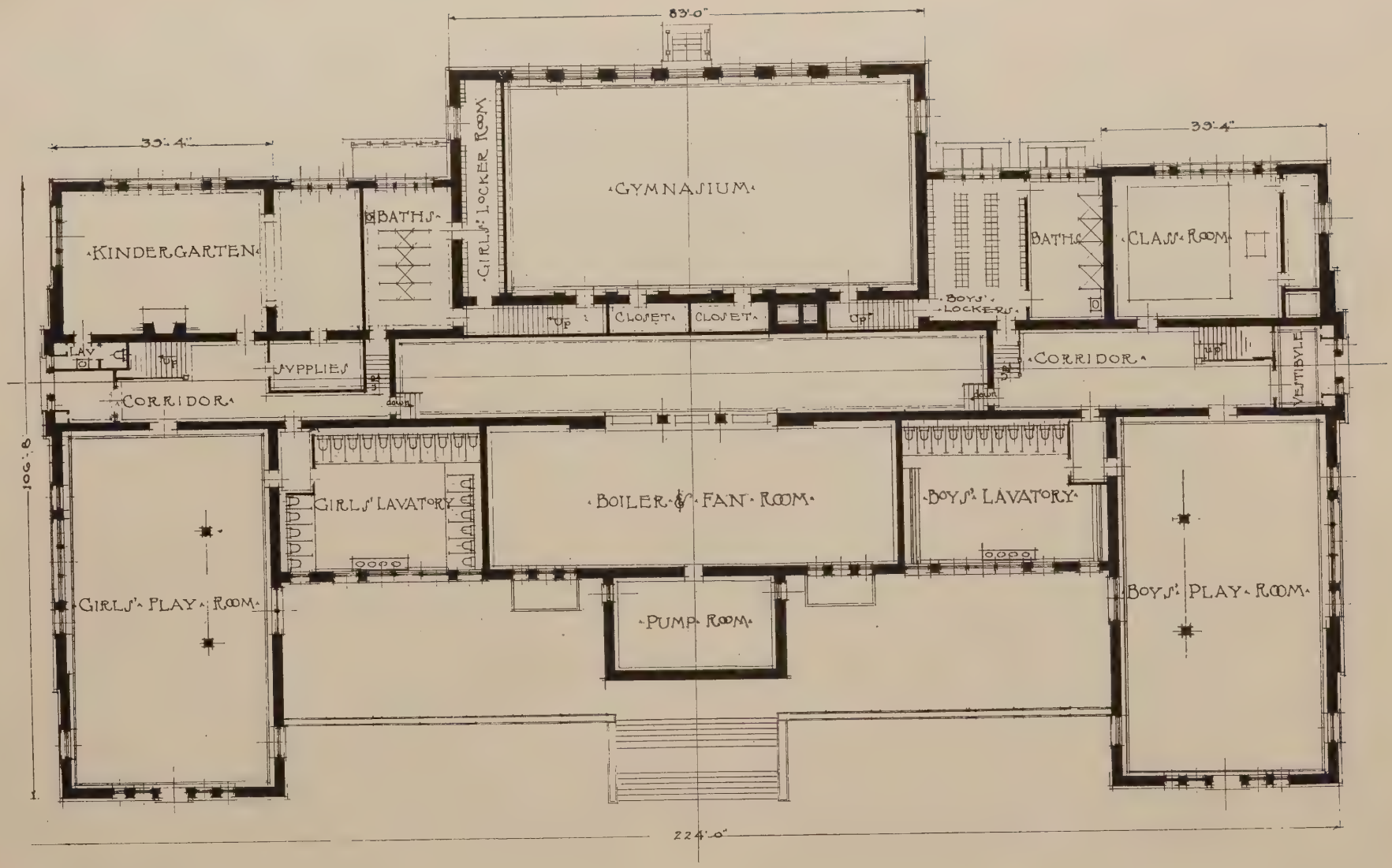
FIG. 561. — WESTWOOD PUBLIC SCHOOL, CINCINNATI, OHIO.

Messrs. Garber and Woodward, Architects.



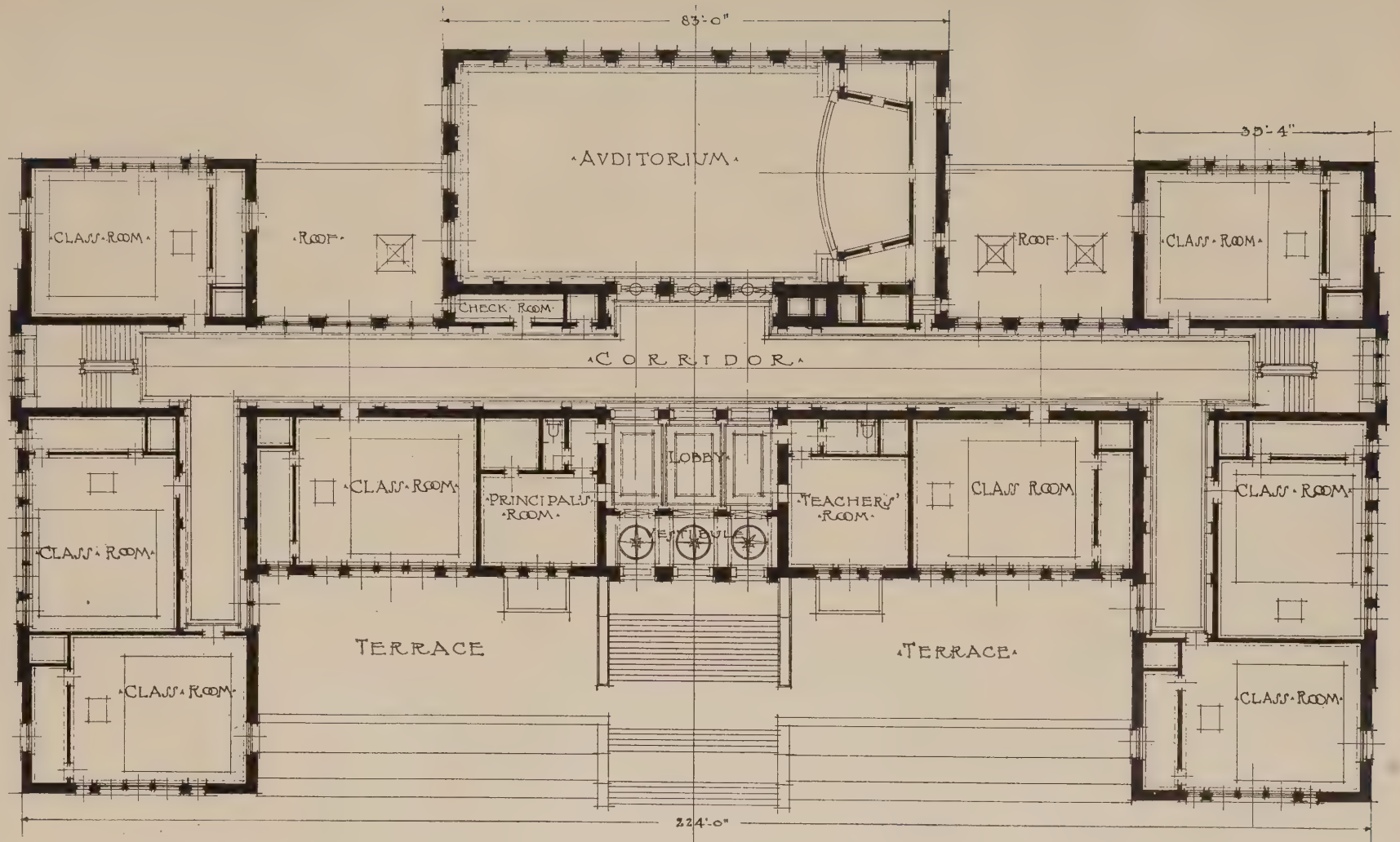
GROUND FLOOR PLAN

0 5 10 15 20

WESTWOOD PUBLIC SCHOOL

GARBER & WOODWARD ARCH'TS. CIN'TI O.

FIG. 562.



FIRST FLOOR PLAN

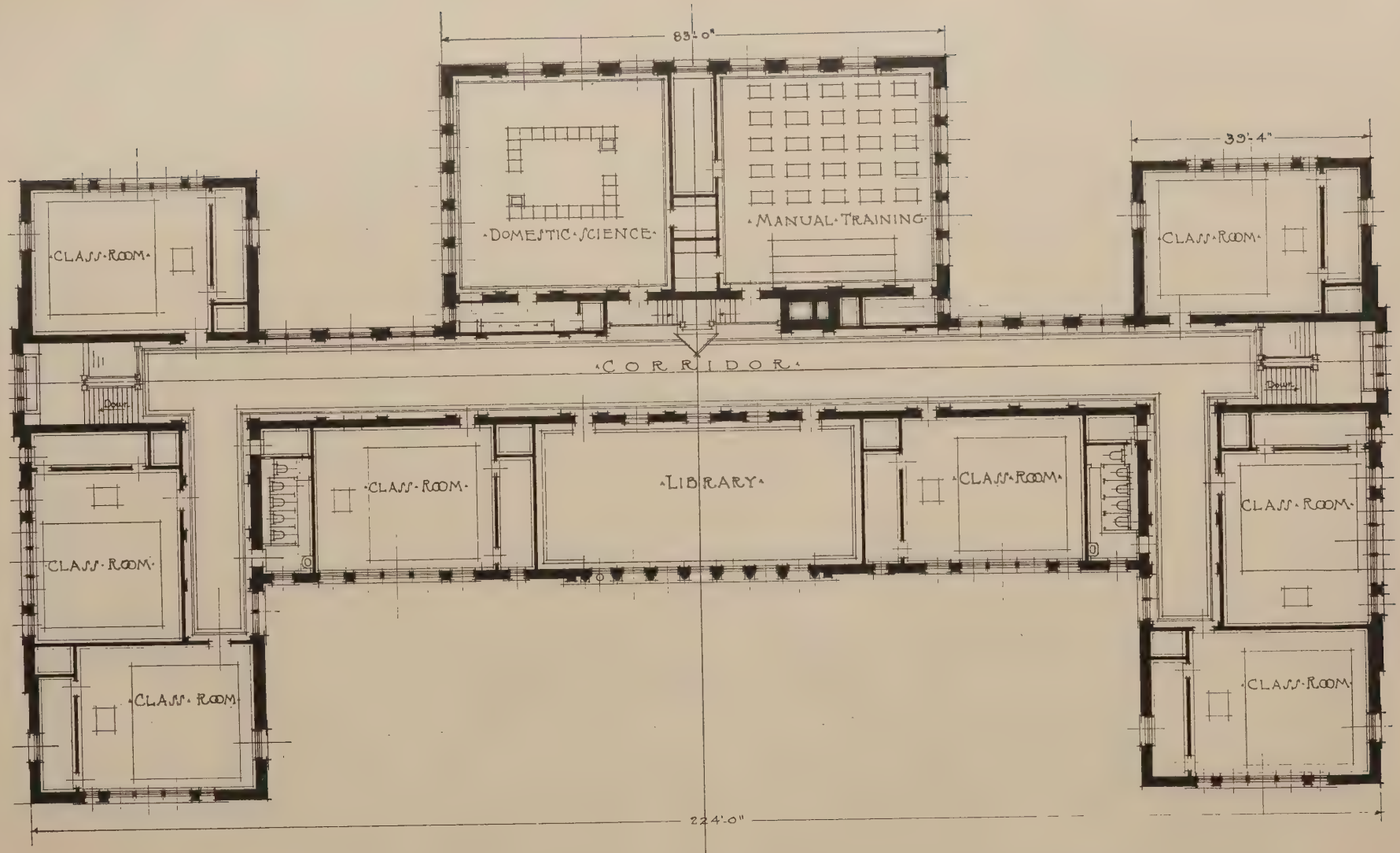
0 5 10 15 20 ft.

SCALE

FIG. 563.

WESTWOOD PUBLIC SCHOOL

GARBER & WOODWARD ARCHTS CINTI O



SECOND FLOOR PLAN

0 5 10 15 20
SCALE

WESTWOOD PUBLIC SCHOOL
GARBER & WOODWARD ARCHTS CINTI O

FIG. 564

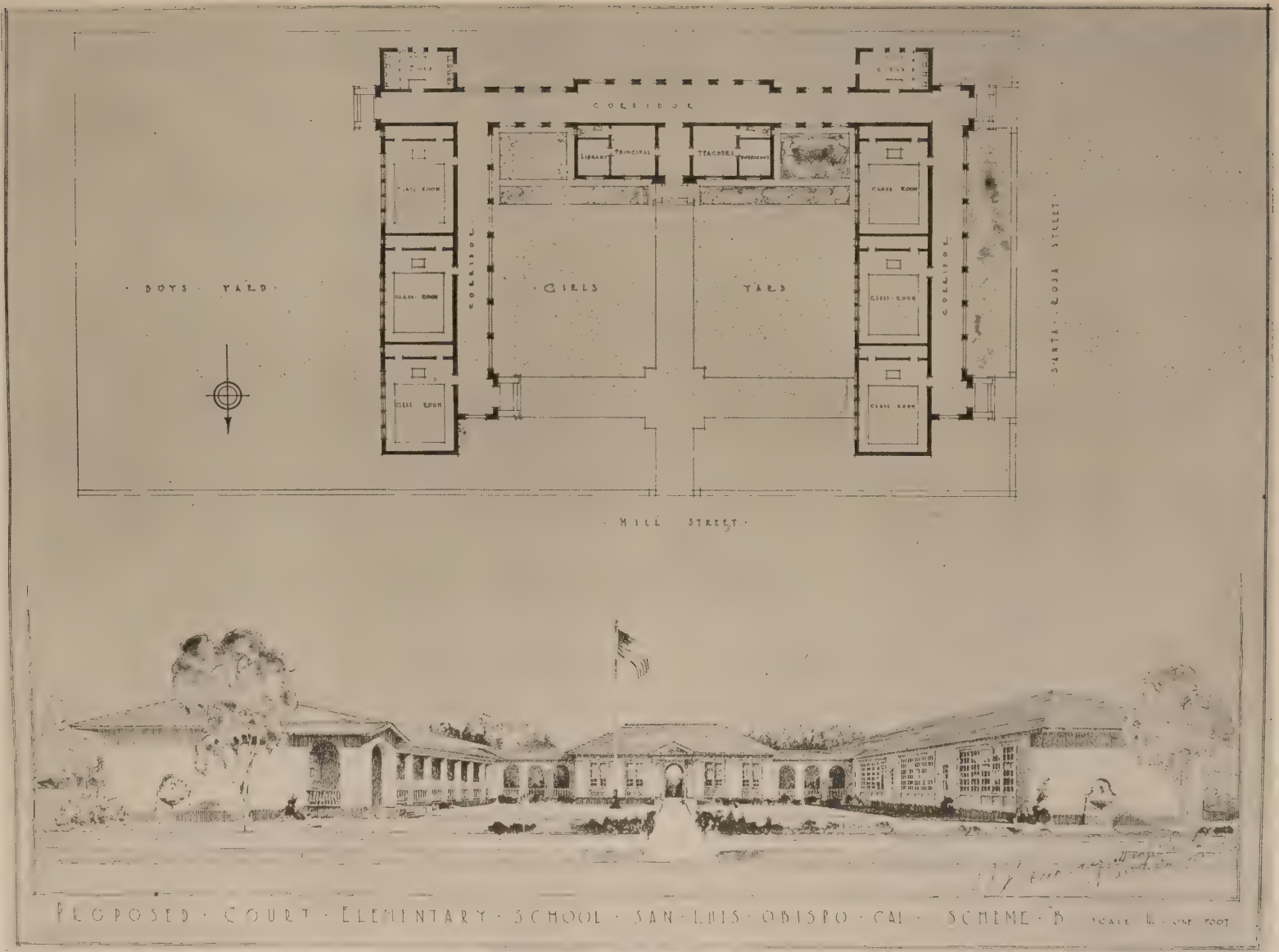


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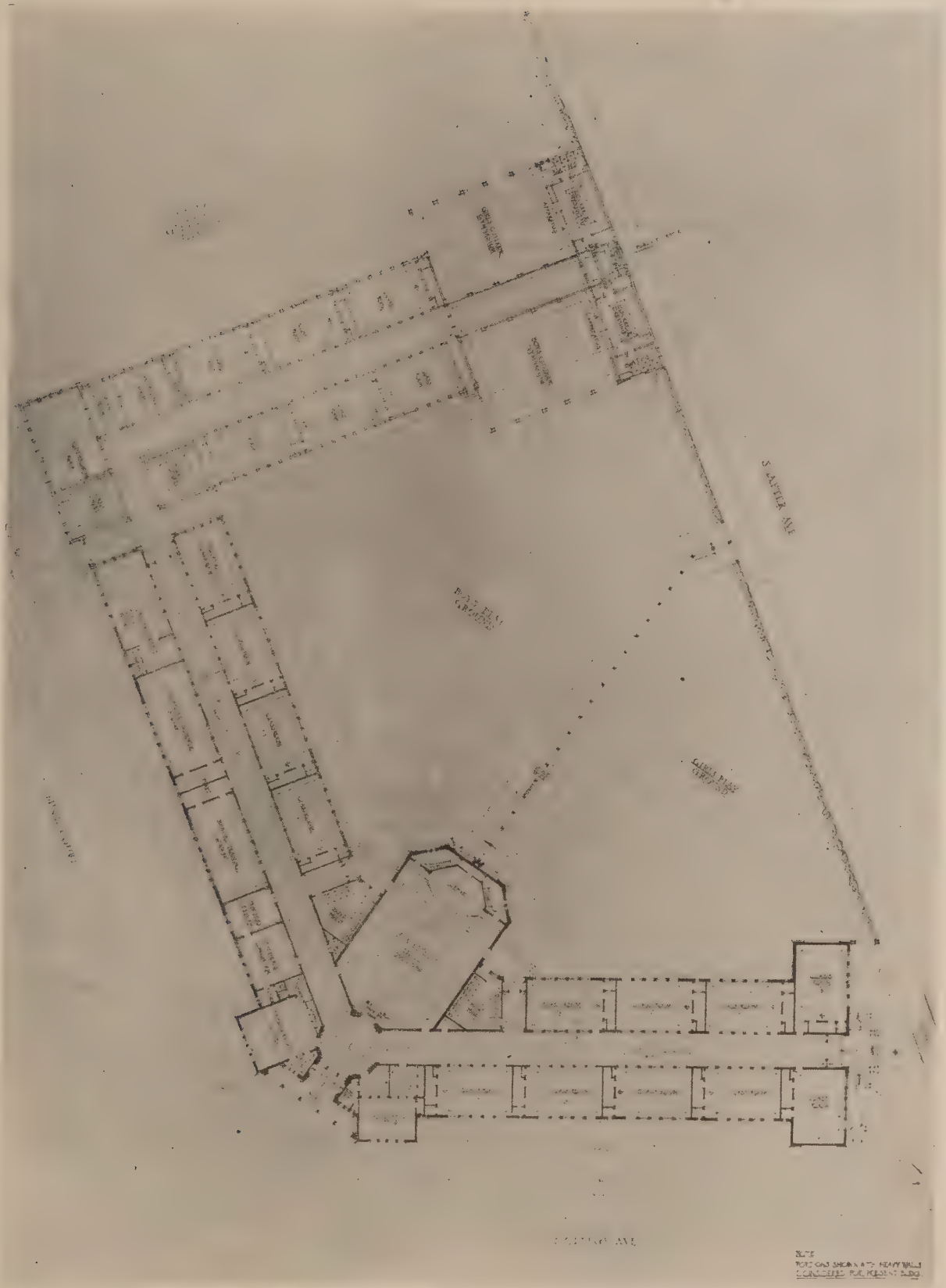
FIG. 565.

Mr. John J. Donovan, Architect

Mr. John J. Donovan, Architect, and Mr. Walter D. Reed, Associate Architect.

FIG. 566. — CLAREMONT ELEMENTARY SCHOOL, OAKLAND, CALIFORNIA.



Mr. John J. Donovan, Architect, and Mr. Walter D. Reed, Associate Architect.

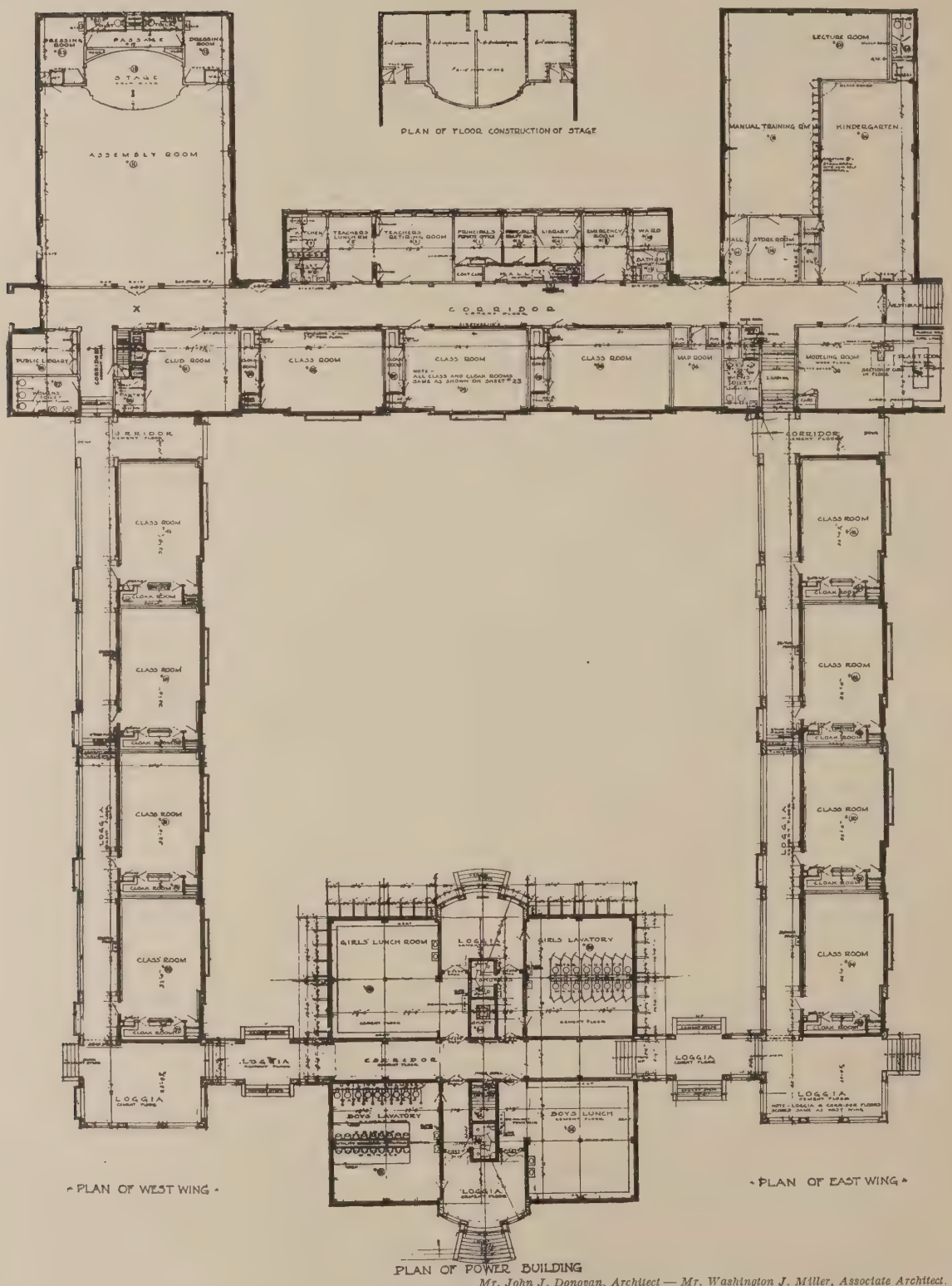
FIG. 567.— CLAREMONT ELEMENTARY SCHOOL, OAKLAND, CALIFORNIA.

Mr. John J. Donovan, Architect — Mr. Washington J. Miller, Associate Architect.

FIG. 568. — JEFFERSON SCHOOL, OAKLAND, CALIFORNIA.

FIG. 569. — JEFFERSON SCHOOL, OAKLAND, CALIFORNIA.

Mr. John J. Donovan, Architect — Mr. Washington J. Miller, Associate Architect.

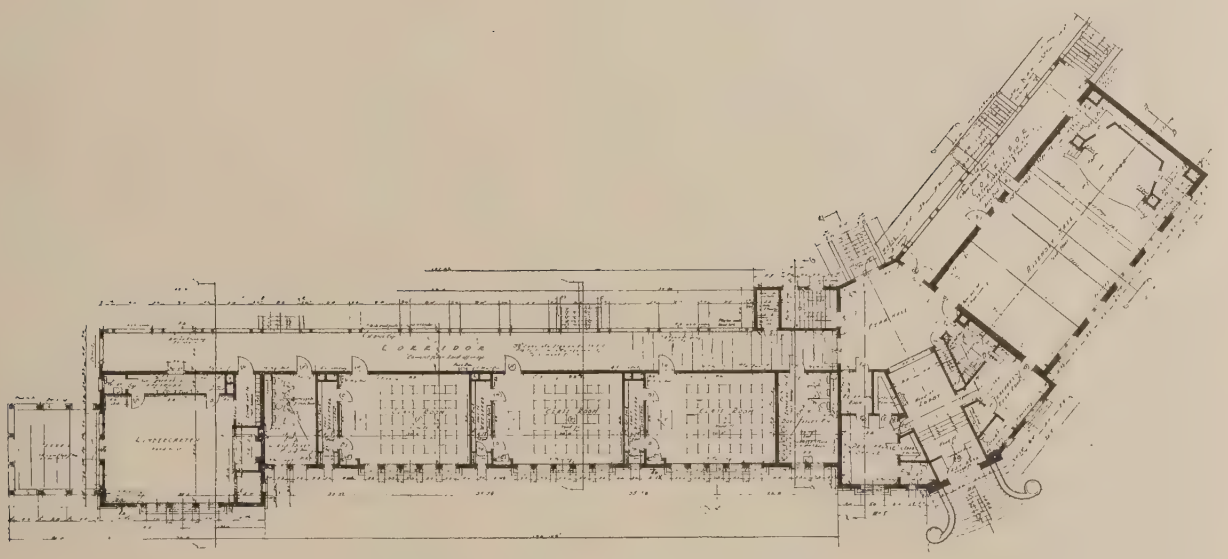


Mr. John J. Donovan, Architect — Mr. Washington J. Miller, Associate Architect.

FIG. 570. — JEFFERSON SCHOOL, OAKLAND, CALIFORNIA.

Mr. John J. Donovan, Architect.

FIG. 571. — ELEMENTARY SCHOOL, ALBANY, CALIFORNIA.



Mr. John J. Donovan, Architect.

FIG. 572. — ELEMENTARY SCHOOL, ALBANY, CALIFORNIA.

Mr. W. R. McCornack, Architect.

FIG. 573. — ADDISON SCHOOL, CLEVELAND, OHIO.

Mr. W. R. McCornack, Architect.

FIG. 574. — ADDISON SCHOOL, CLEVELAND, OHIO.

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FIG. 575. — ADDISON SCHOOL, CLEVELAND, OHIO.

Mr. W. R. McCornack, Architect.

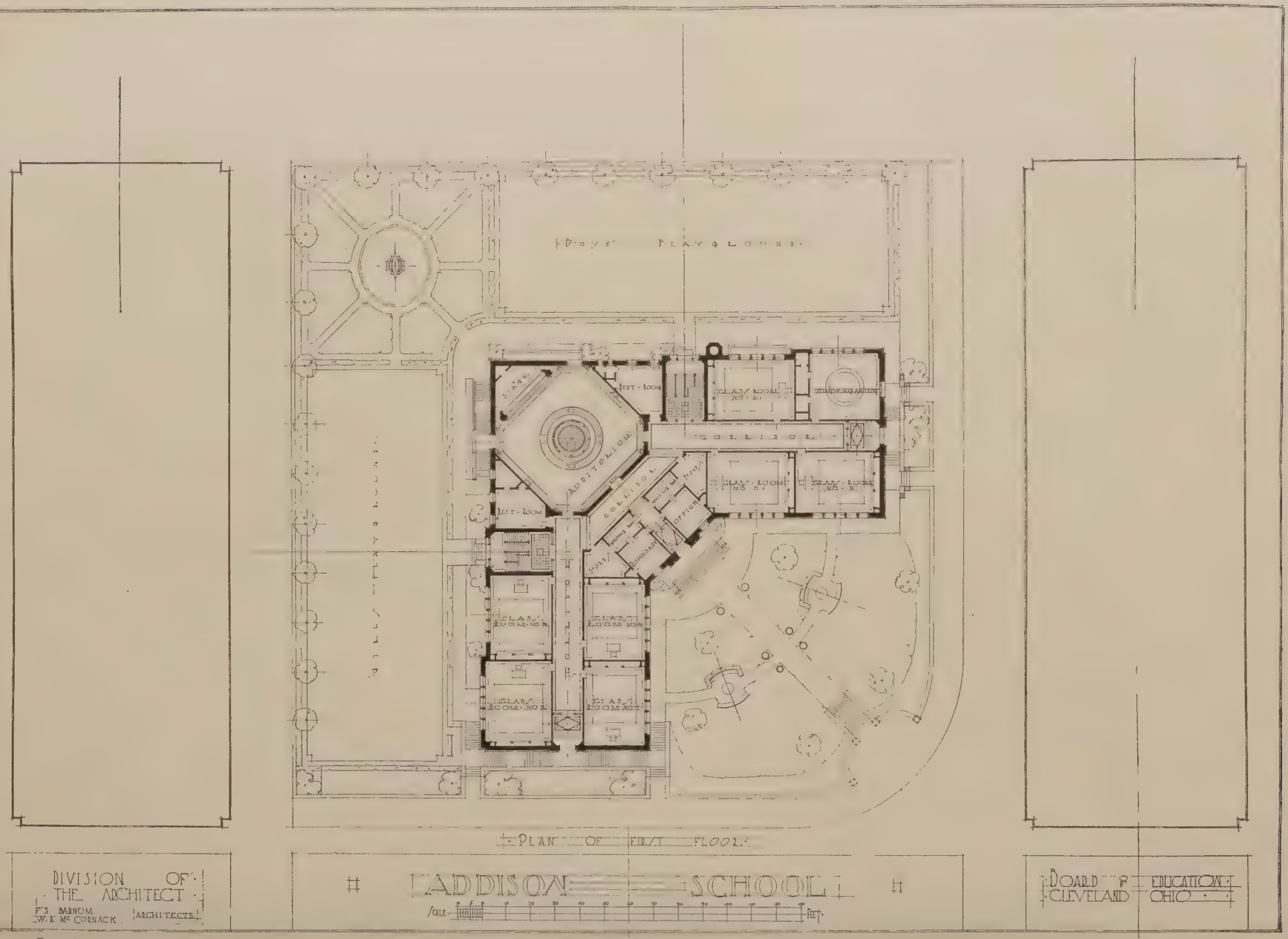
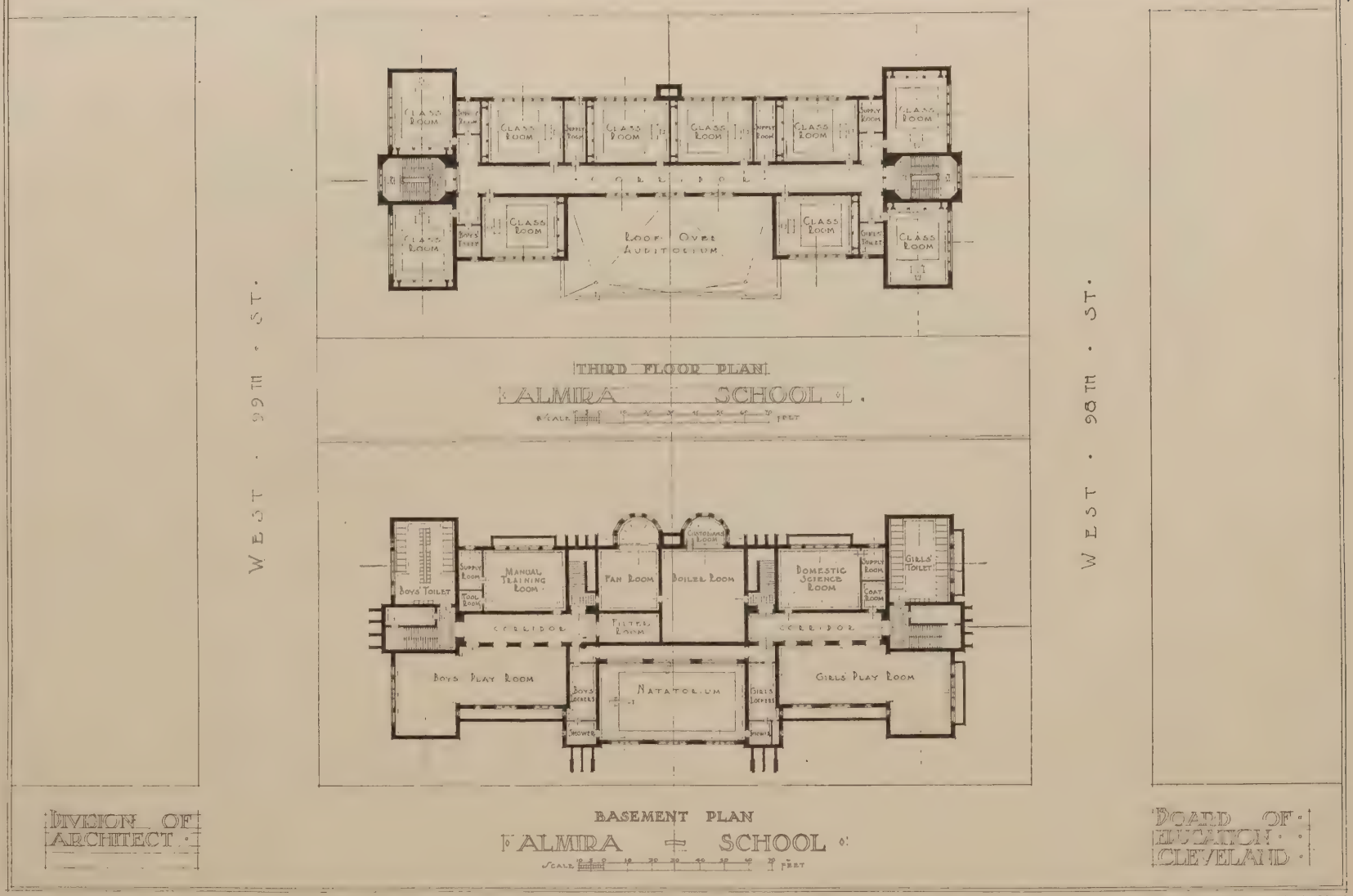

Boys' Play Ground
Girls' Play Ground
Auditorium
Corridor
Class Room No. 1
Class Room No. 2
Class Room No. 3
Class Room No. 4
Class Room No. 5
Class Room No. 6
Manual Training
Office
Toilet
Toilet
Toilet
Toilet
Plan of First Floor
Division of the Architect
F. S. Barnum
W. R. Mc Cornack
Architects
Addison School
Scale
Feet
Board of Education
Cleveland Ohio

FIG. 576.

FIG. 577. — ALMIRA SCHOOL, CLEVELAND, OHIO.

Mr. W. R. McCornack, Architect.



Mr. W. R. McCornack, Architect.

FIG. 578.

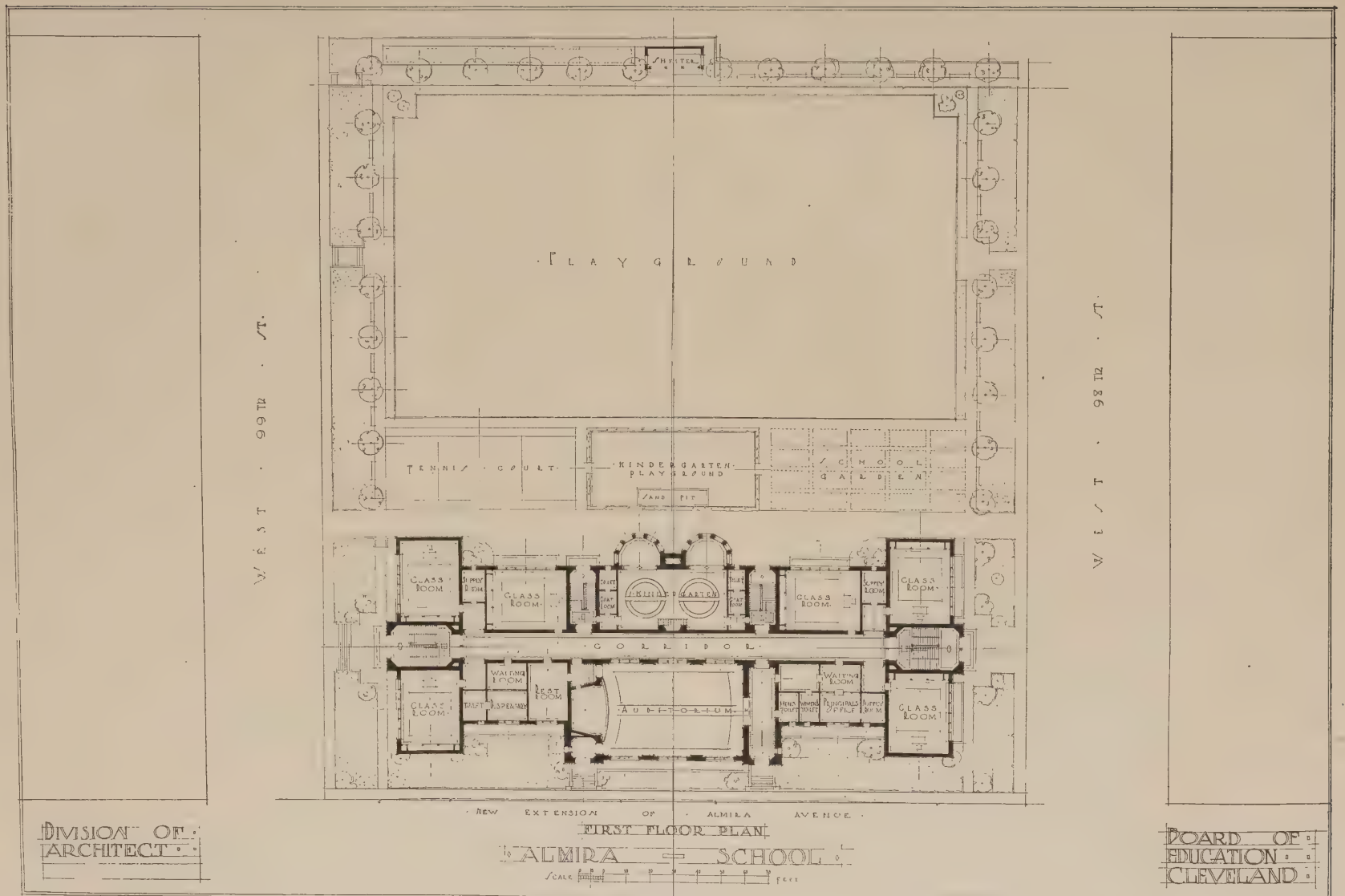


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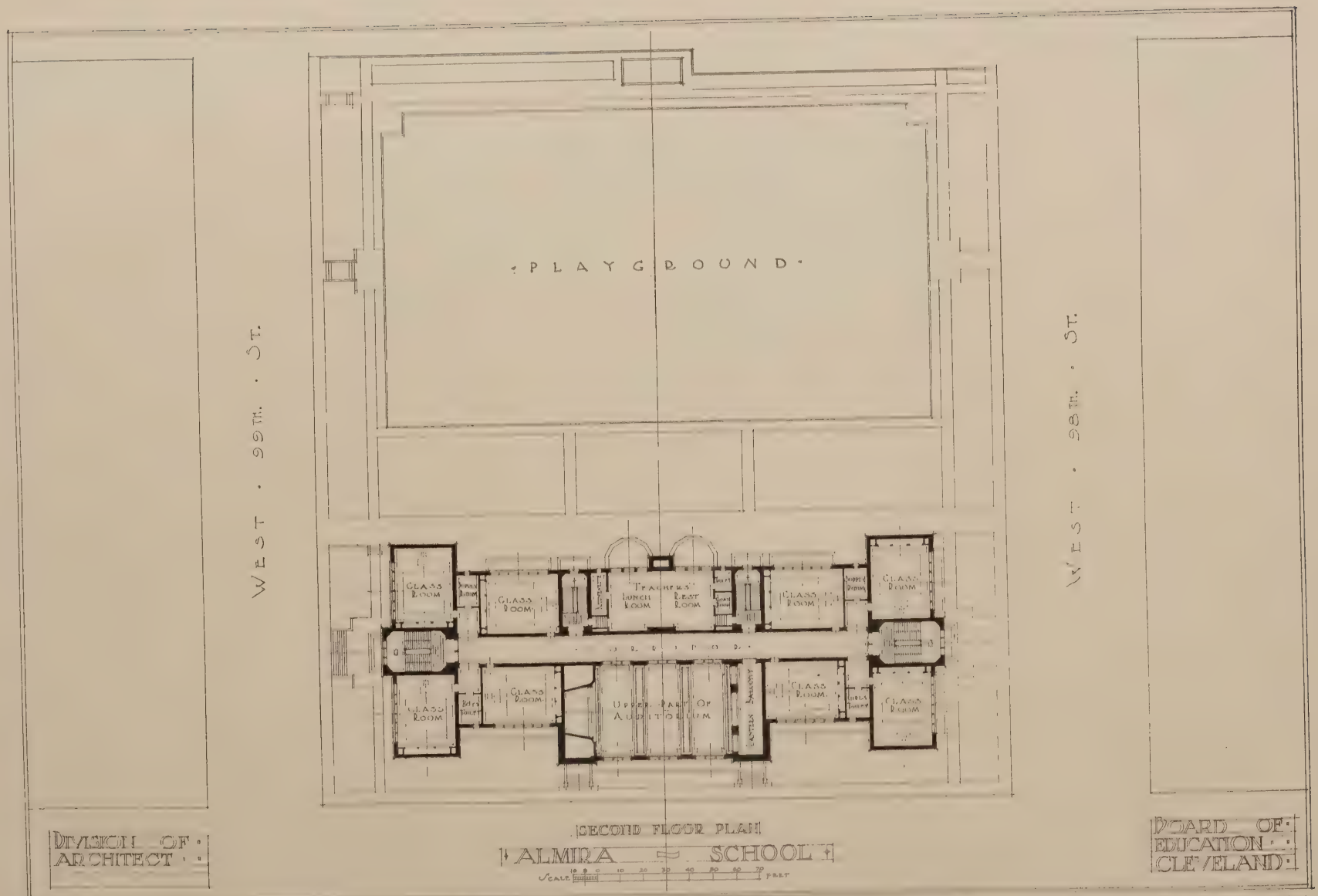
FIG. 579.

Mr. W. R. McCornack, Architect.

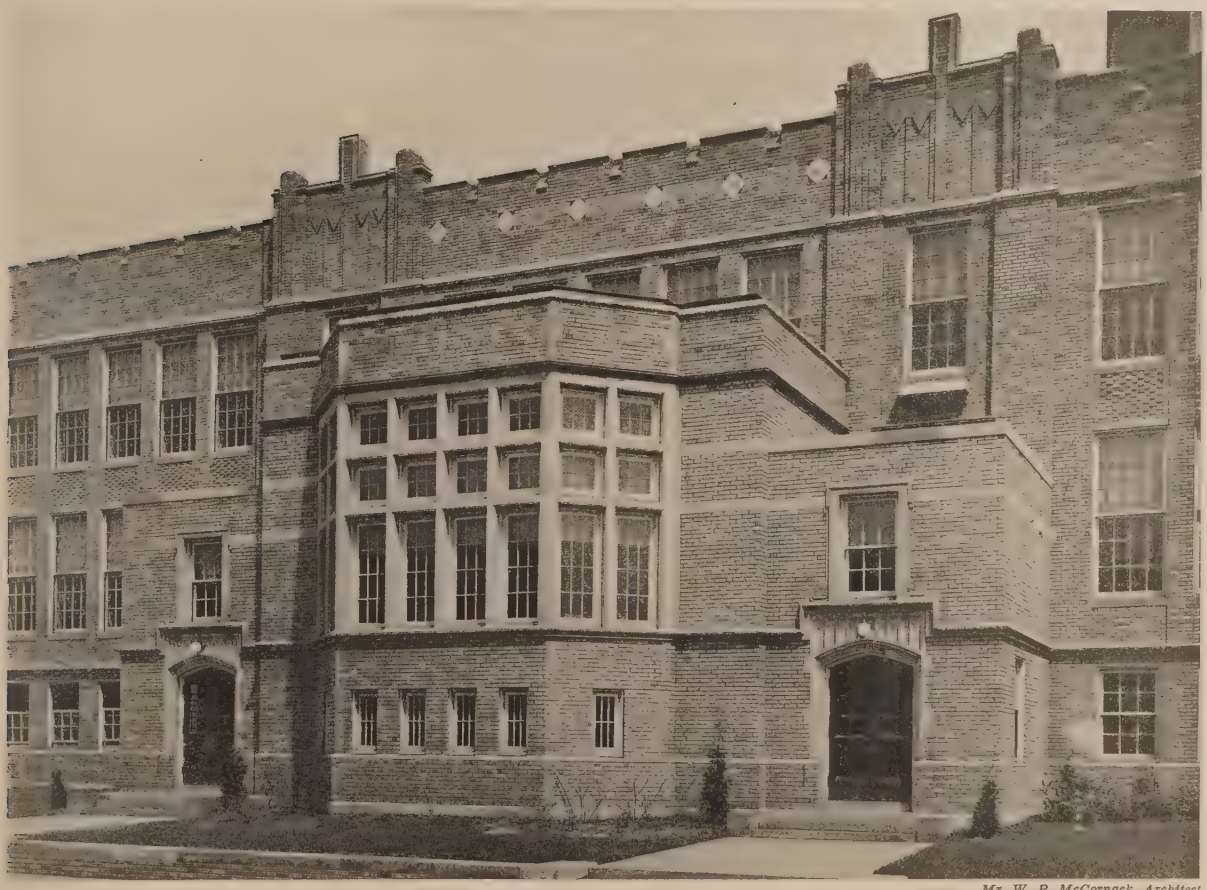


Mr. W. R. McCormack, Architect.

FIG. 580.

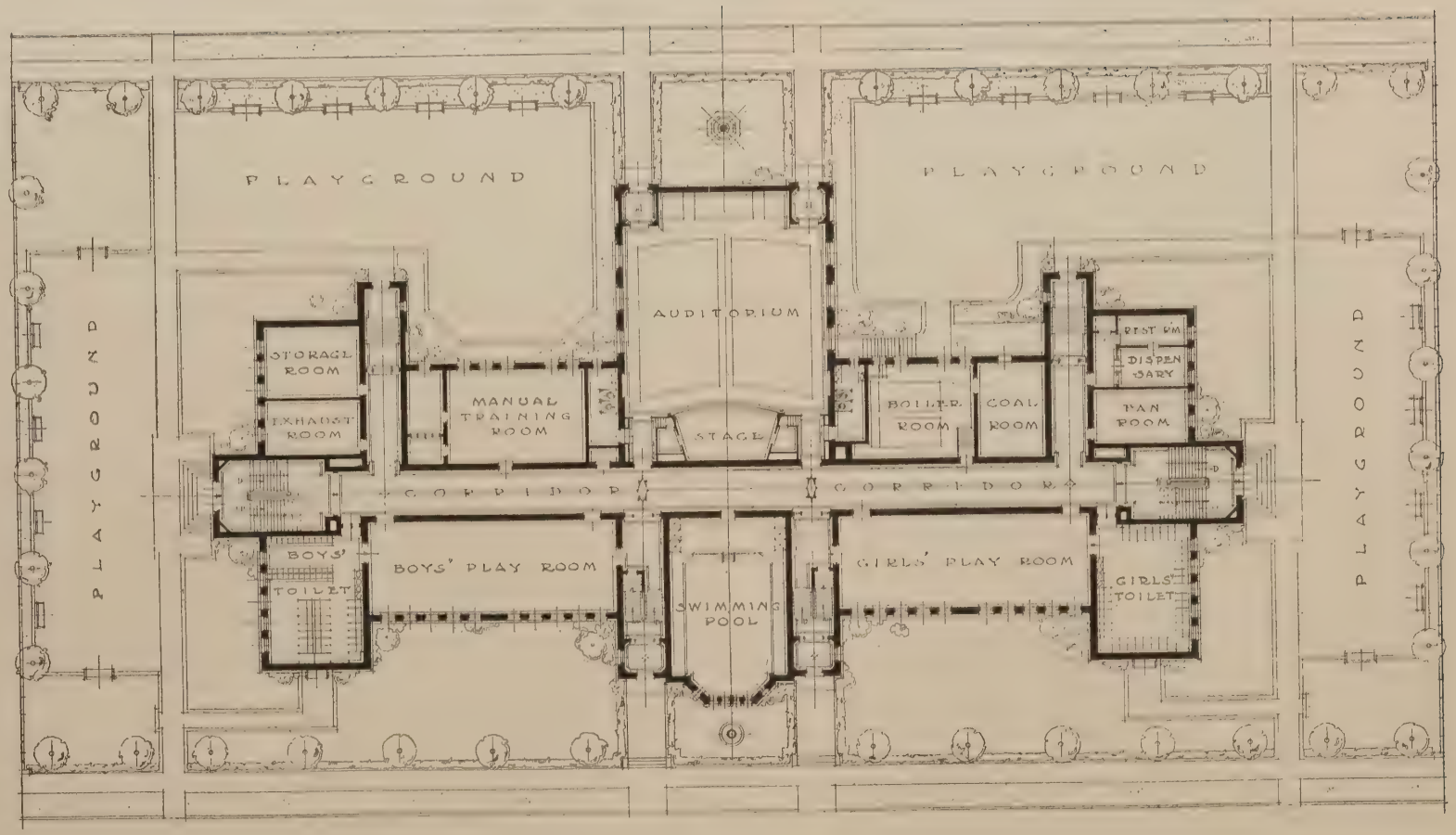
Mr. W. R. McCornack, Architect.

FIG. 581. — EMPIRE SCHOOL, CLEVELAND, OHIO.



Mr. W. R. McCornack, Architect.

FIG. 582. — EMPIRE SCHOOL, CLEVELAND, OHIO.



GROUND FLOOR PLAN

EMPIRE SCHOOL

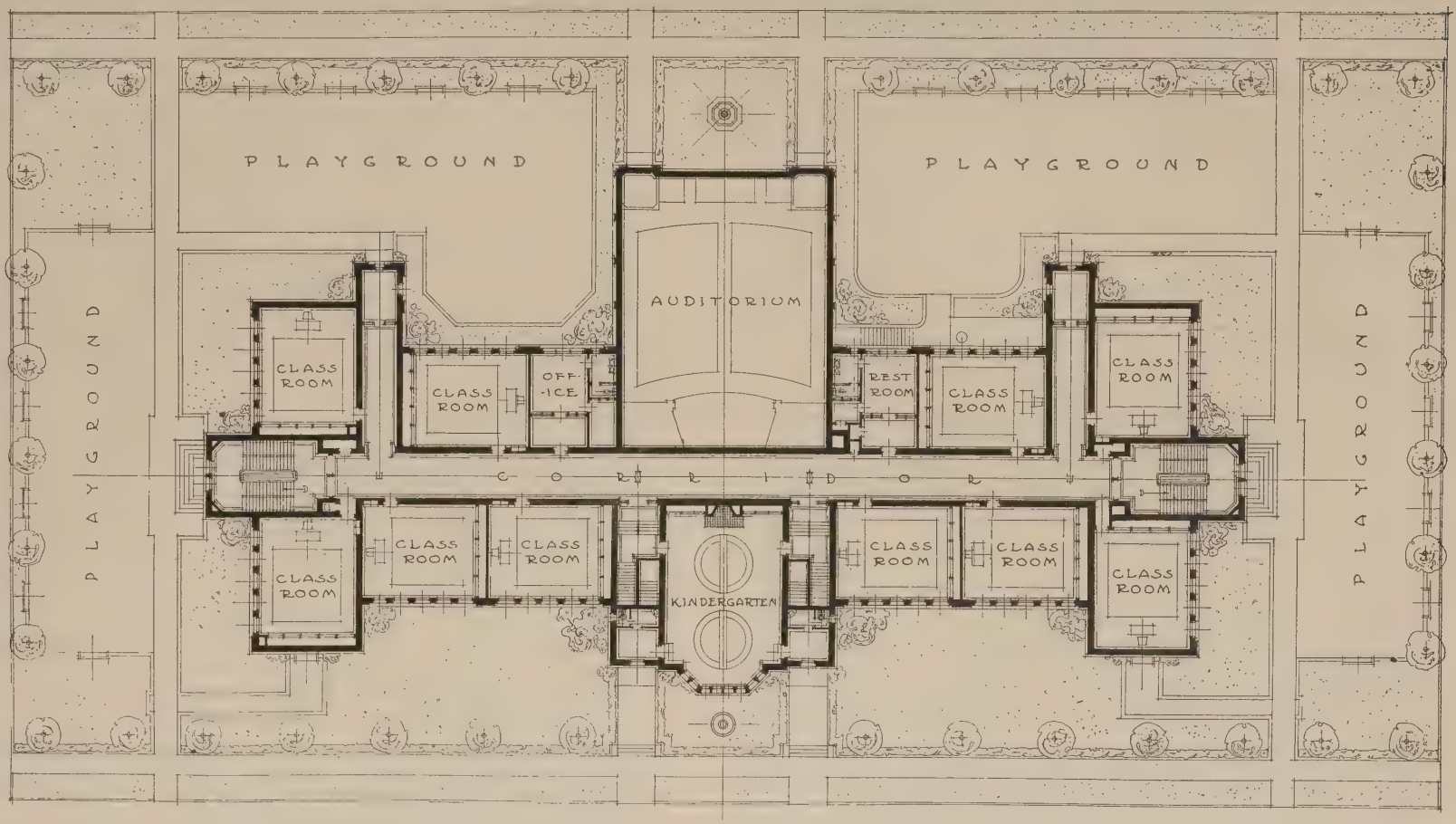
DIVISION OF ARCHITECT

BOARD OF EDUCATION CLEVELAND

SCALE 0 10 20 30 FEET

W. R. McCornack, Architect.

FIG. 583.



FIRST FLOOR PLAN.

EMPIRE SCHOOL

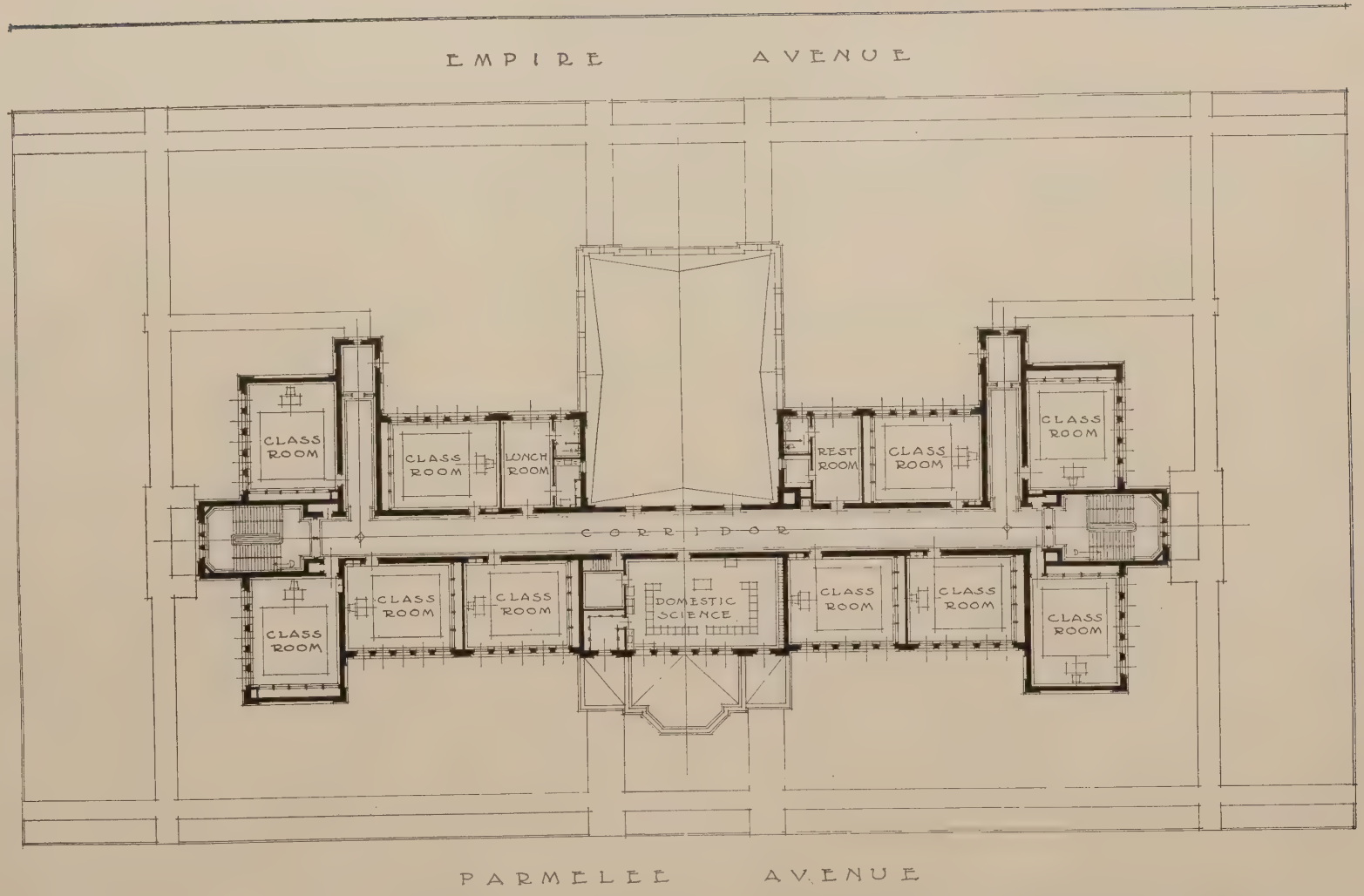
DIVISION OF ARCHITECT

BOARD OF EDUCATION CLEVELAND

SCALE 0 10 20 30 FEET

FIG. 584.

Mr. W. R. McCornack, Architect.



SECOND FLOOR PLAN

EMPIRE SCHOOL

DIVISION OF ARCHITECT

BOARD OF EDUCATION CLEVELAND

SCALE 0 10 20 30 FEET

Mr. W. R. McCornack, Architect.

FIG. 585.

Mr. William B. Ittner, Architect.

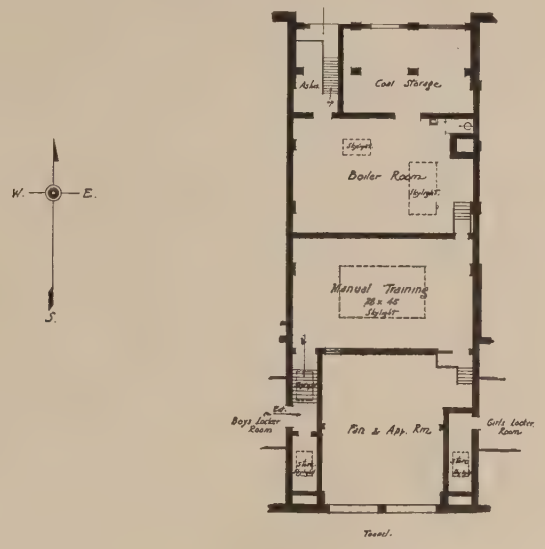
FIG. 586. — HIGH SCHOOL, GREENFIELD, OHIO.

Mr. William B. Ittner, Architect.

FIG. 587. — HIGH SCHOOL, GREENFIELD, OHIO.

Mr. William B. Ittner, Architect.

FIG. 588. — HIGH SCHOOL, GREENFIELD, OHIO.

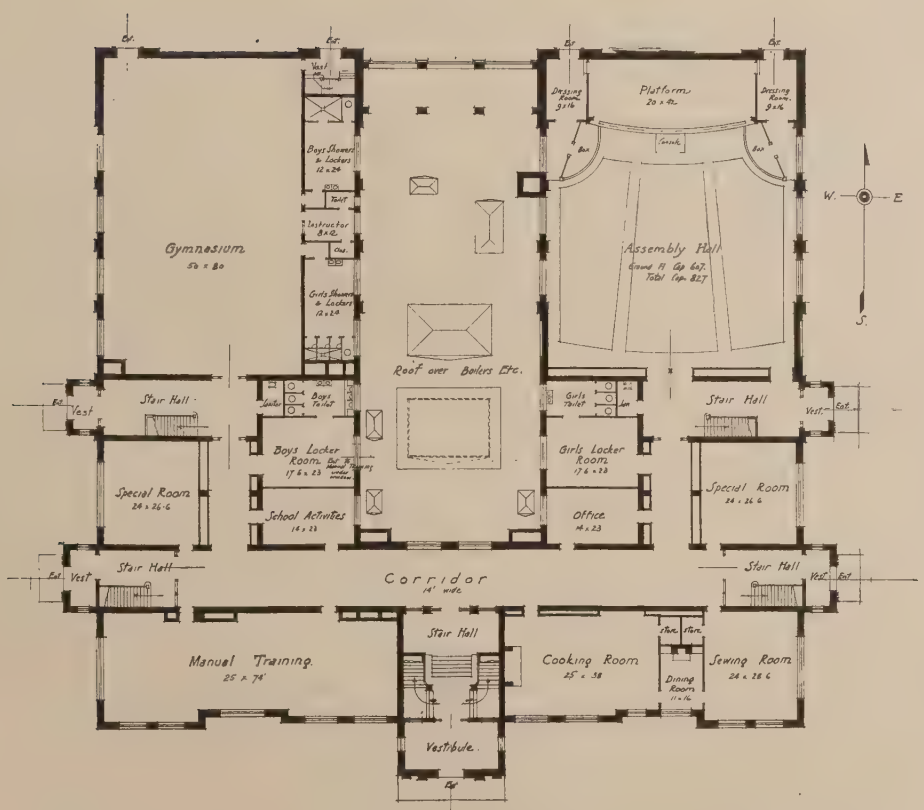


·BASEMENT · FLOOR · PLAN·
SCALE : 1/8 INCH · EQUALS · 1 · FOOT·

·SKETCH · PLAN ·
·HIGH · SCHOOL · AT · GREENFIELD · OHIO·
·FOR · MR. · E · L · MC CLAIN·

·WM · B · ITTNER · ARCHITECT·
ST LOUIS MISSOURI. DEC. 1918·

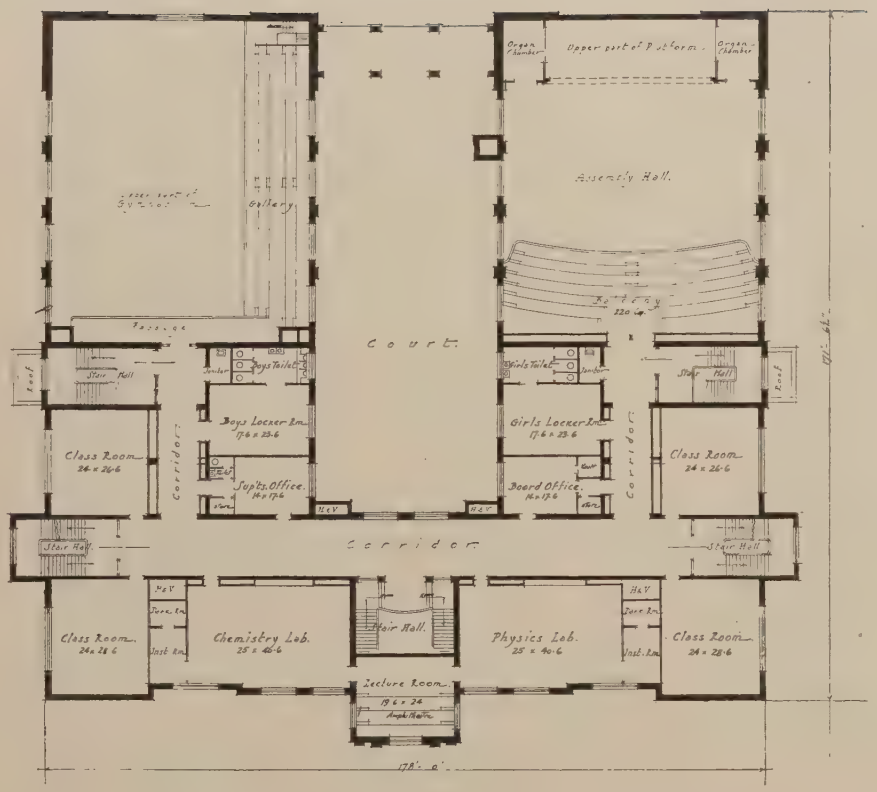
FIG. 589.



·GROUND · FLOOR · PLAN·

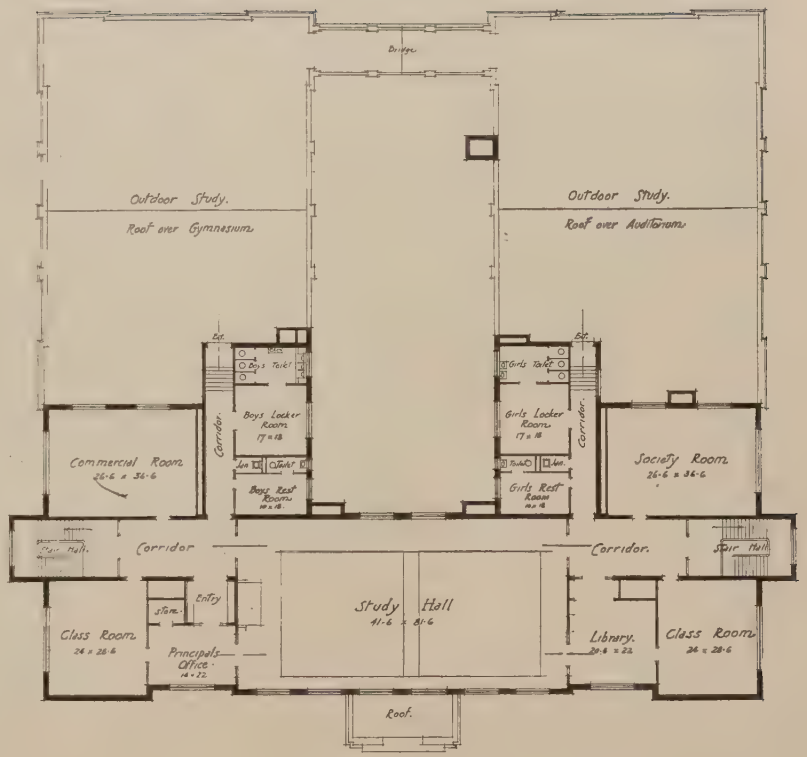
Mr. William B. Ittner, Architect.

FIG. 590.—HIGH SCHOOL, GROUND FLOOR PLAN, GREENFIELD, OHIO.



·FIRST · FLOOR · PLAN ·

Mr. William B. Ittner, Architect.



·SECOND · FLOOR · PLAN ·

Mr. William B. Ittner, Architect.

Page 652 FIG. 591. — HIGH SCHOOL, FIRST FLOOR PLAN, GREENFIELD, OHIO.

FIG. 592. — HIGH SCHOOL, SECOND FLOOR PLAN, GREENFIELD, OHIO.

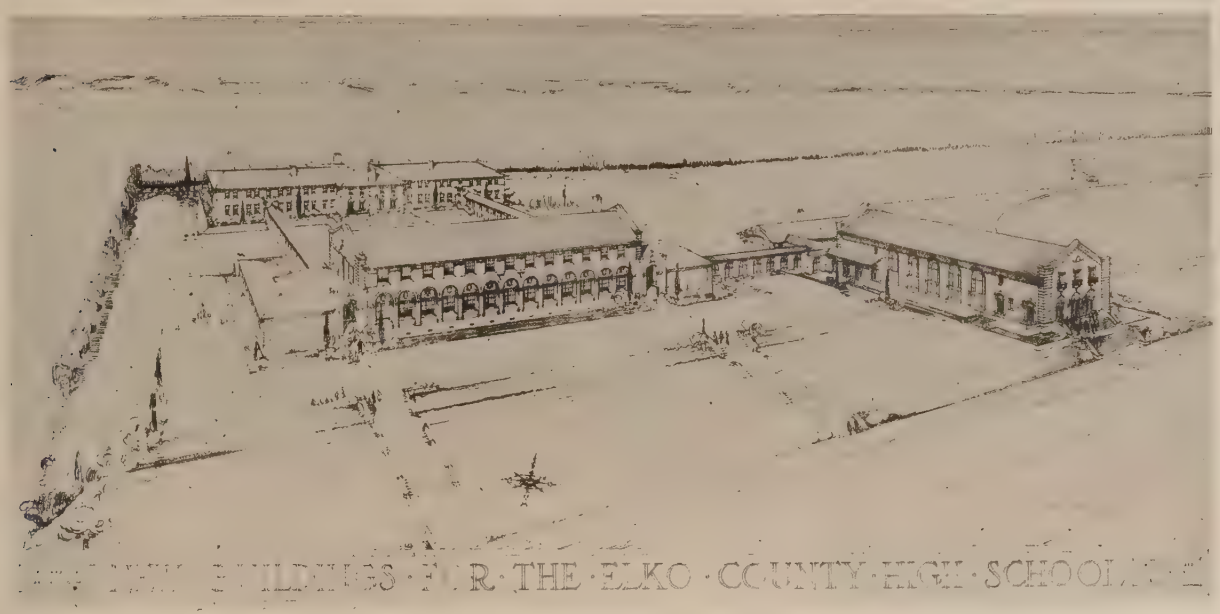
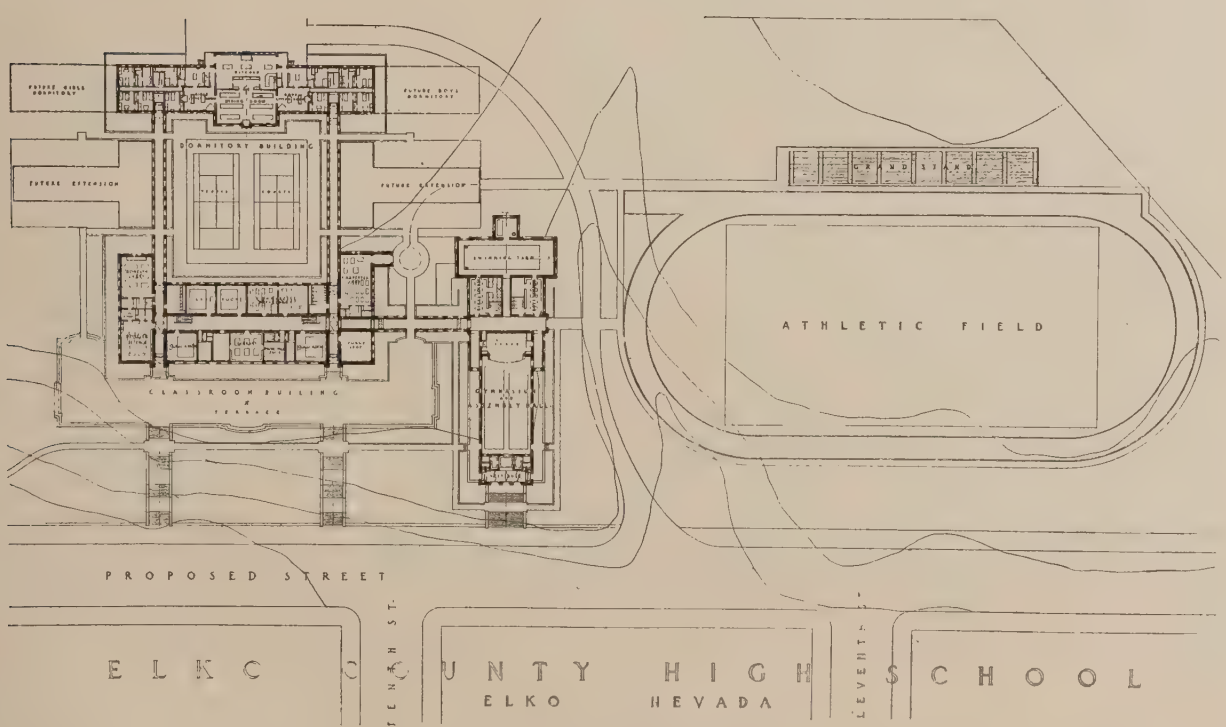
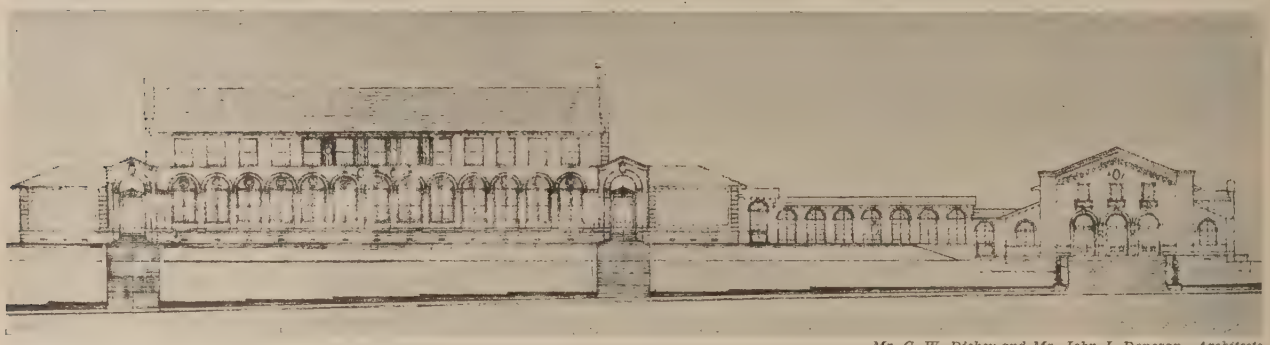


FIG. 593.



ELKO COUNTY HIGH SCHOOL, ELKO, NEVADA
C. W. DICKEY AND JOHN J. DONOVAN, ARCHITECTS

FIG. 594.



Mr. C. W. Dickey and Mr. John J. Donovan, Architects.

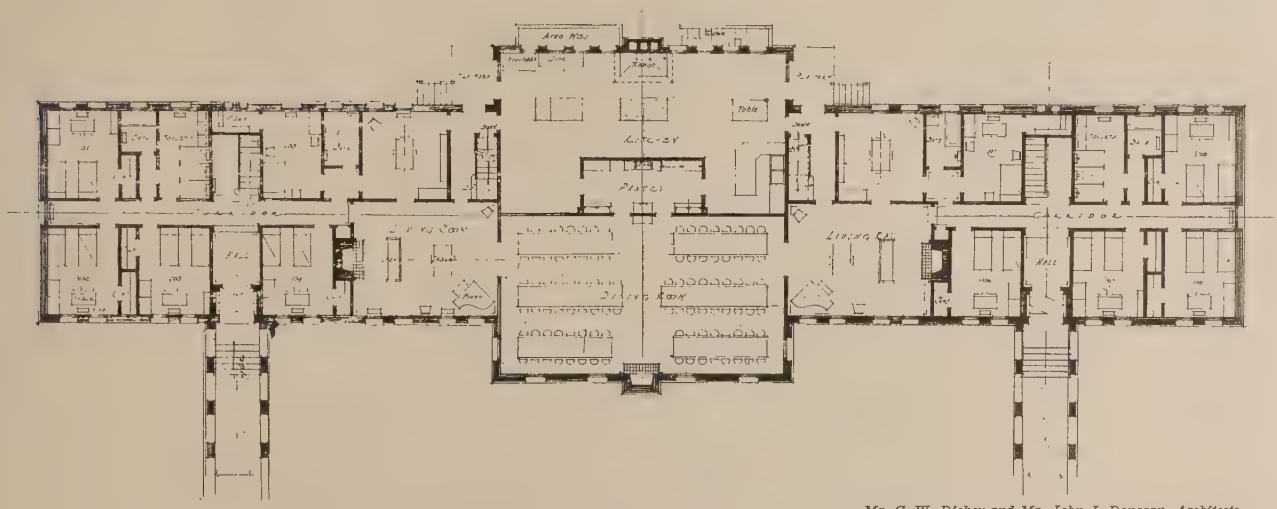
FIG. 595. — ELKO COUNTY HIGH SCHOOL, GENERAL ELEVATION, ELKO, NEVADA.

Mr. C. W. Dickey and Mr. John J. Donovan, Architects.

FIG. 596. — ELKO COUNTY HIGH SCHOOL, MAIN FLOOR PLAN, ELKO, NEVADA.

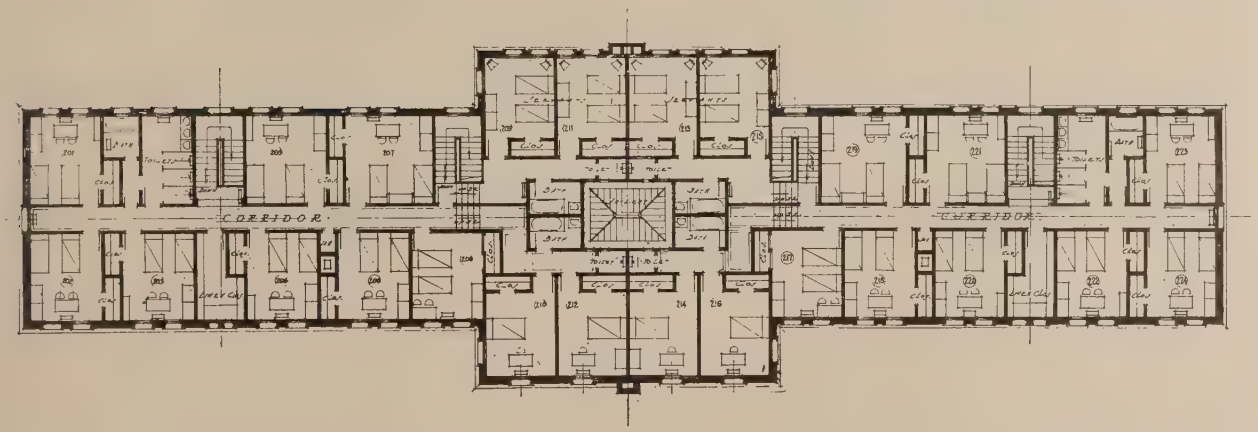
Mr. C. W. Dickey and Mr. John J. Donovan, Architects.

FIG. 597. — ELKO COUNTY HIGH SCHOOL, ELEVATION OF DORMITORY, ELKO, NEVADA.



Mr. C. W. Dickey and Mr. John J. Donovan, Architects.

FIG. 598. — ELKO COUNTY HIGH SCHOOL, FIRST FLOOR PLAN OF DORMITORY, ELKO, NEVADA.



Mr. C. W. Dickey and Mr. John J. Donovan, Architects.

FIG. 599. — ELKO COUNTY HIGH SCHOOL, SECOND FLOOR PLAN OF DORMITORY, ELKO, NEVADA.

Messrs. Perkins, Fellows, and Hamilton, Architects.

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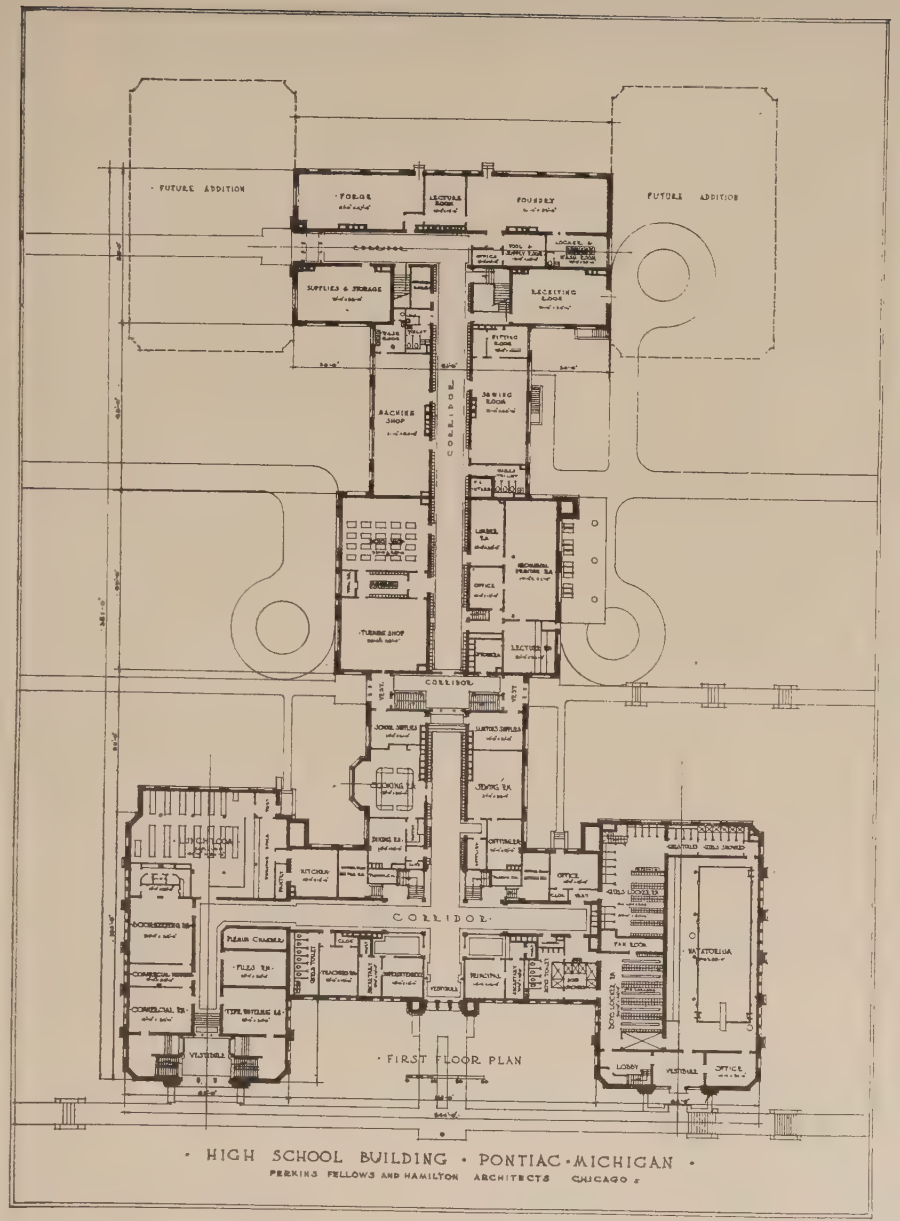
FIG. 600. — HIGH SCHOOL BUILDING, PONTIAC, MICHIGAN.



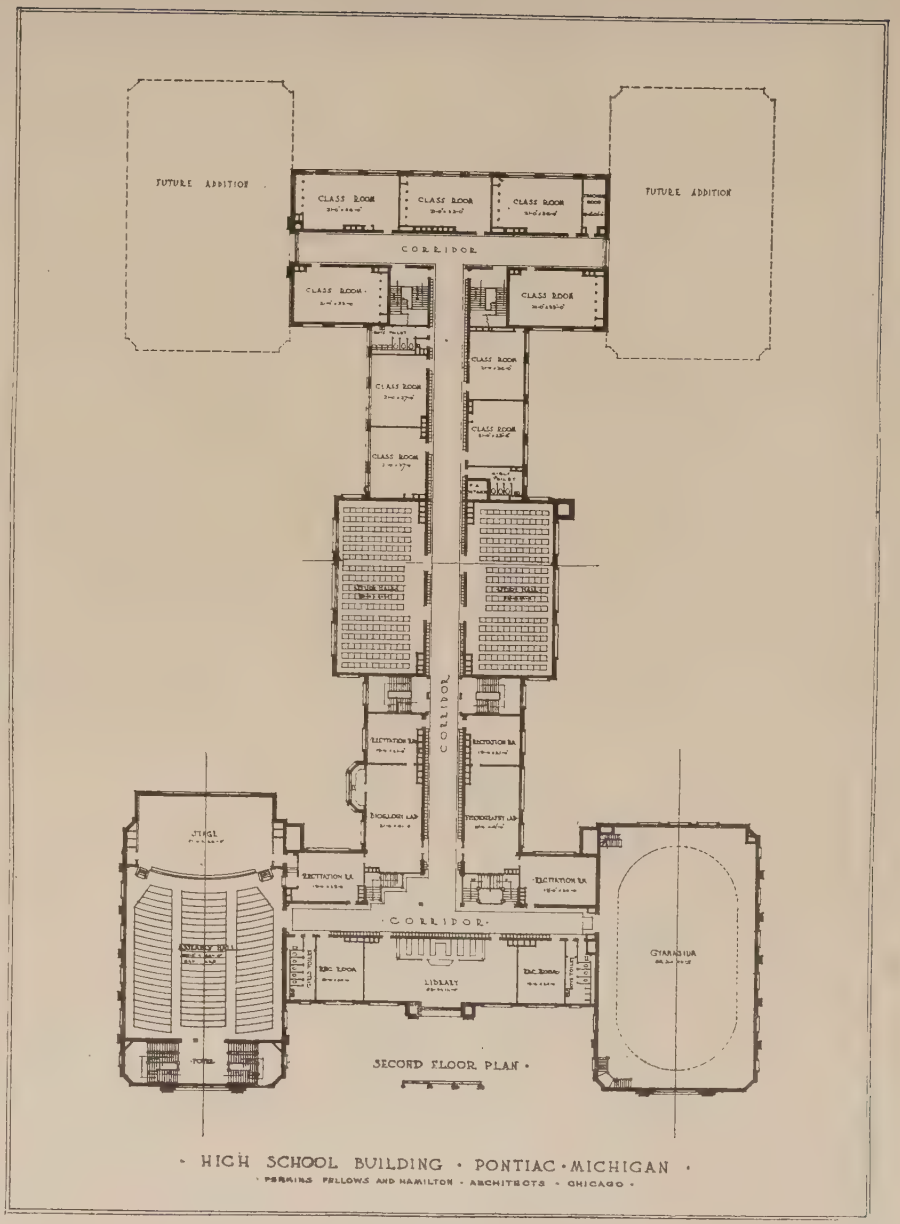


FIG. 601.

FIG. 602.

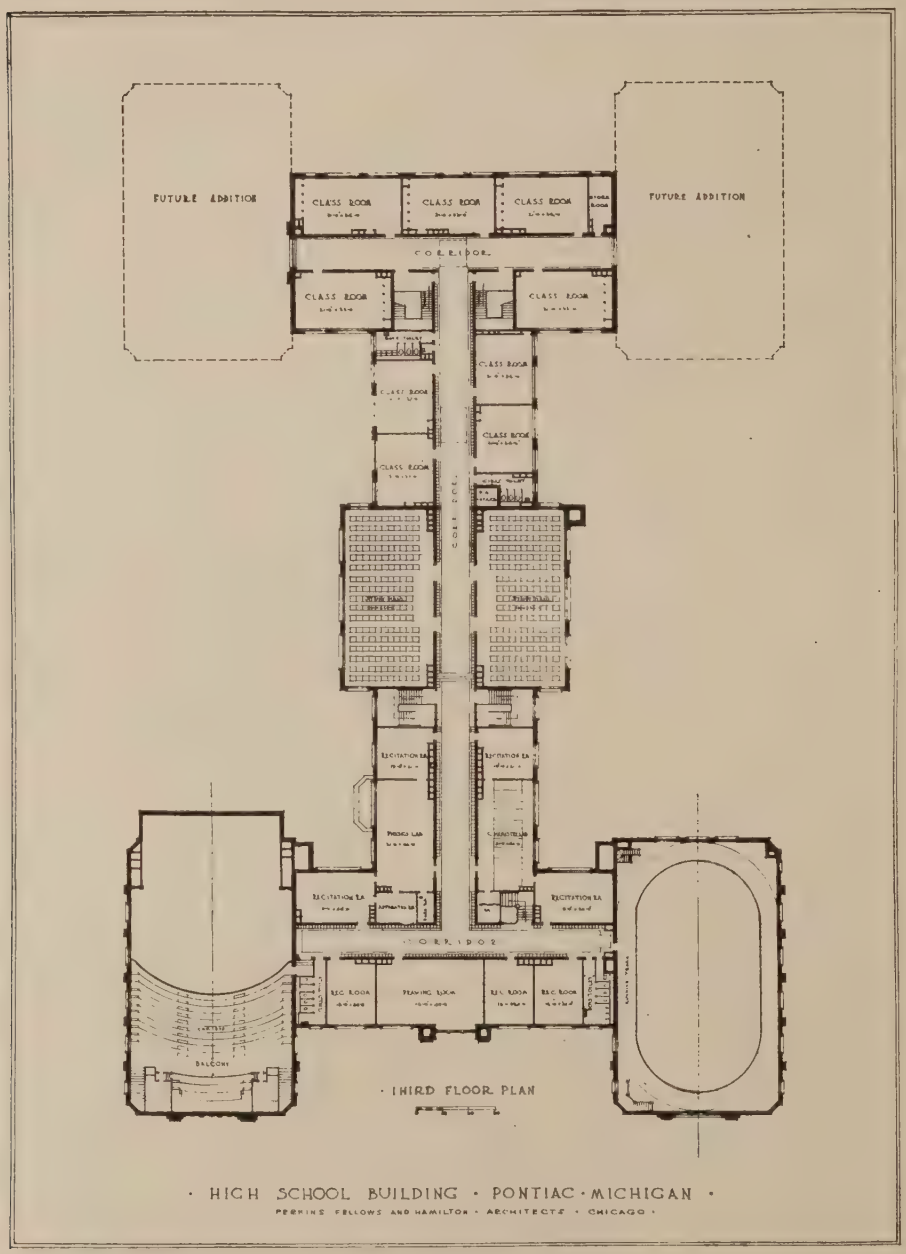
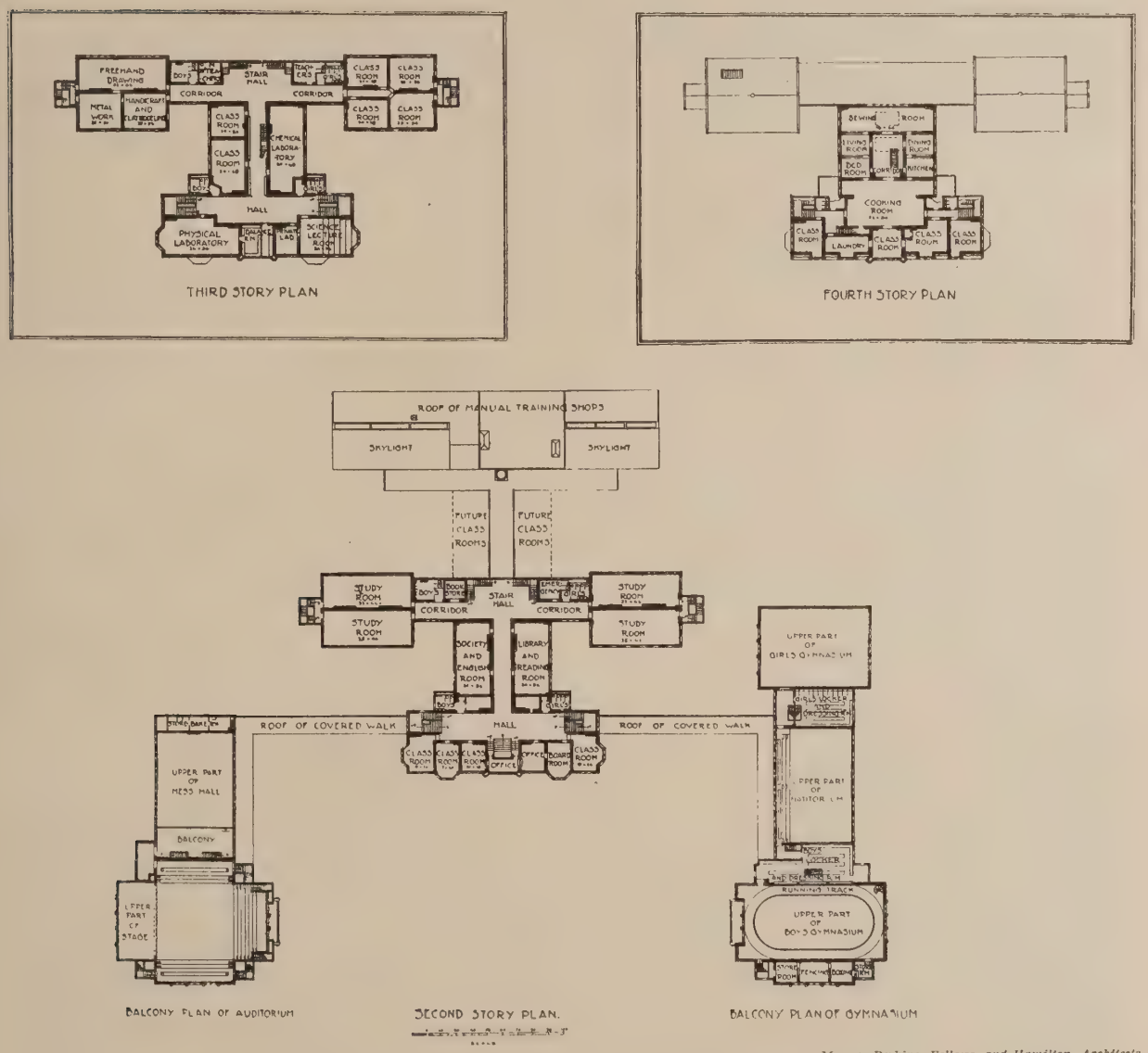
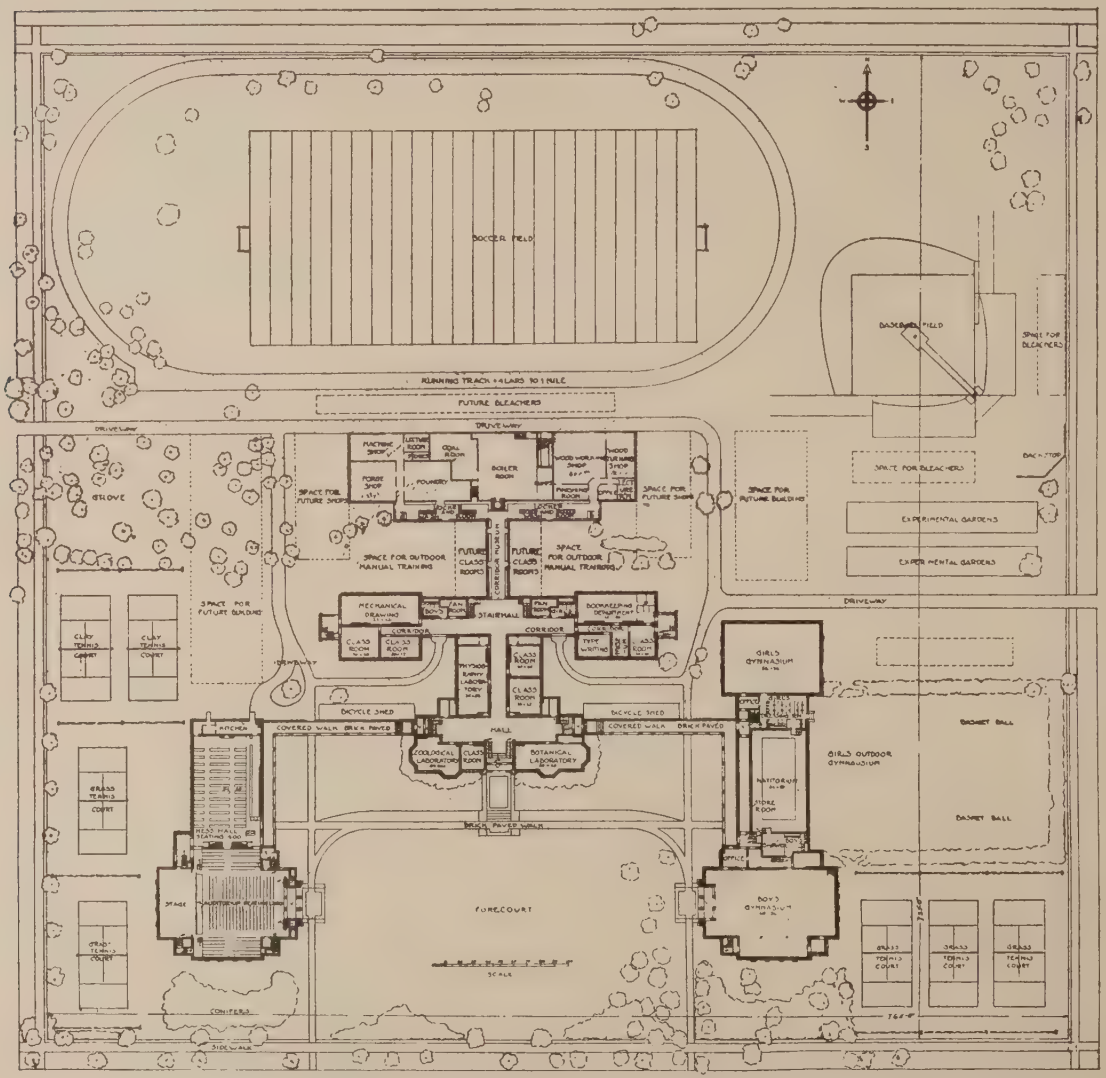

FUTURE ADDITION
CLASS ROOM
CLASS ROOM
CLASS ROOM
FUTURE ADDITION
CORRIDOR
CLASS ROOM
CLASS ROOM
CLASS ROOM
CLASS ROOM
CLASS ROOM
CLASS ROOM
CLASS ROOM
CORRIDOR
EXCITATION LA
EXCITATION LA
PHYSICS LAB
EXCITATION LA
EXCITATION LA
CORRIDOR
REC ROOM
PLAYING ROOM
REC ROOM
REC ROOM
BALCONY
THIRD FLOOR PLAN
HIGH SCHOOL BUILDING · PONTIAC · MICHIGAN
PERKINS FELLOWS AND HAMILTON · ARCHITECTS · CHICAGO

FIG. 603.



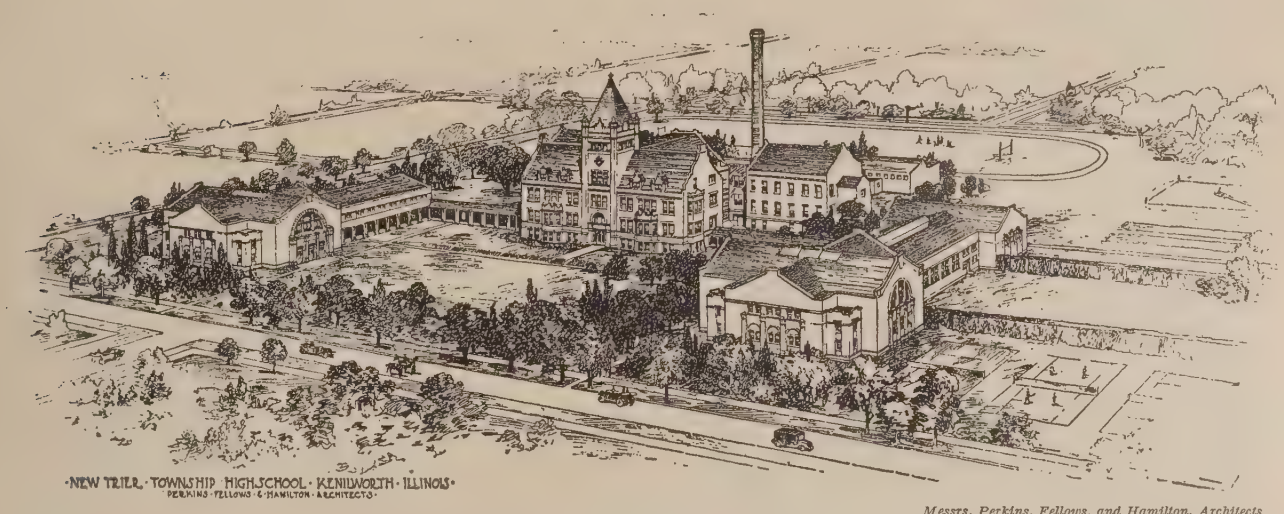
Messrs. Perkins, Fellows, and Hamilton, Architects.

FIG. 604. — NEW TRIER TOWNSHIP HIGH SCHOOL, KENILWORTH, ILLINOIS.



PLAT OF NEW TRIER TOWNSHIP HIGH SCHOOL, KENILWORTH, ILLINOIS.
PERKINS, FELLOWS & HAMILTON, ARCHITECTS, CHICAGO.
1912.

FIG. 605.

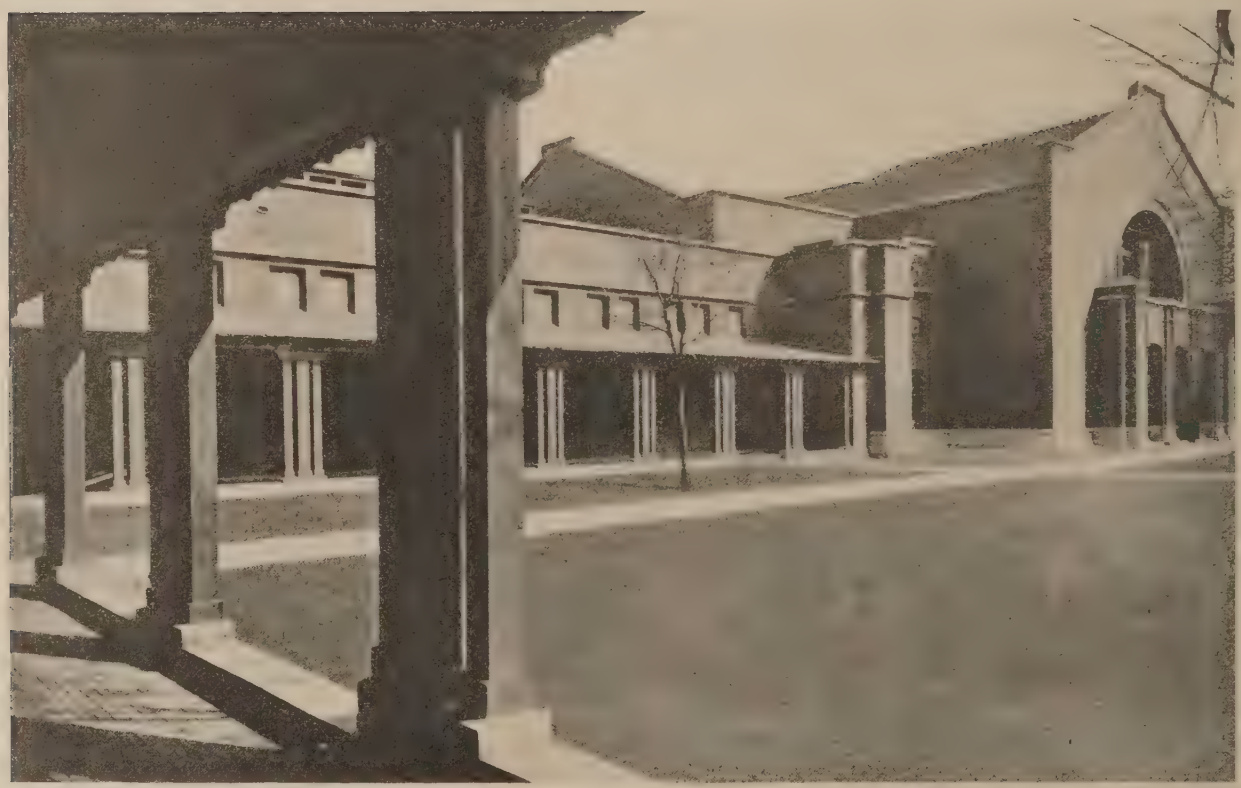


Messrs. Perkins, Fellows, and Hamilton, Architects

FIG. 606. — NEW TRIER TOWNSHIP HIGH SCHOOL, KENILWORTH, ILLINOIS.

Messrs. Perkins, Fellows, and Hamilton, Architects.

FIG. 607. — NEW TRIER TOWNSHIP HIGH SCHOOL, KENILWORTH, ILLINOIS.



Messrs. Perkins, Fellows, and Hamilton, Architects.

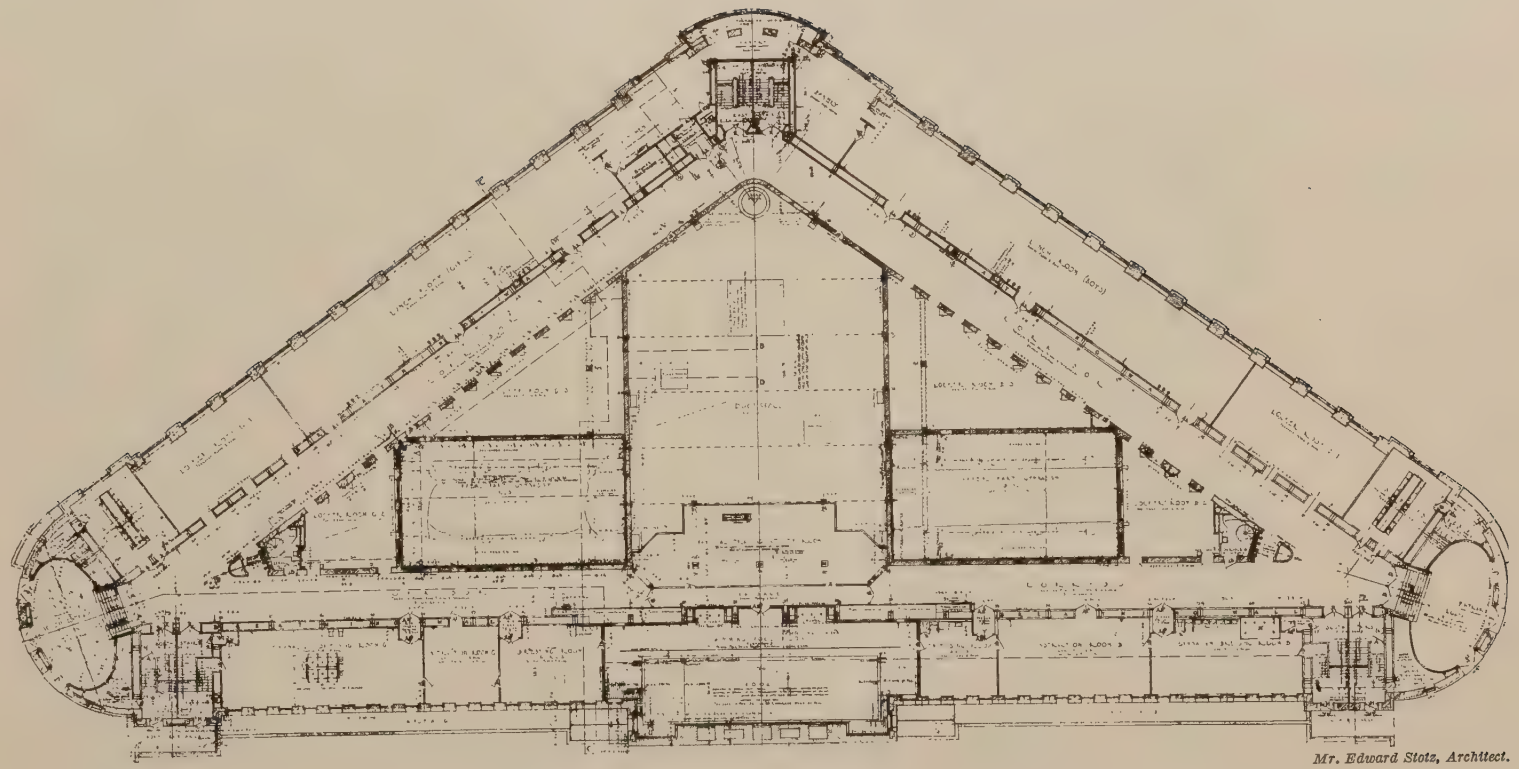
FIG. 608. — NEW TRIER TOWNSHIP HIGH SCHOOL, KENILWORTH, ILLINOIS.

Mr. Edward Stotz, Architect.

FIG. 609. — SCHENLEY HIGH SCHOOL, PITTSBURGH, PENNSYLVANIA.

Mr. Edward Stotz, Architect.

FIG. 610. — SCHENLEY HIGH SCHOOL, PITTSBURGH, PENNSYLVANIA.



Mr. Edward Stotz, Architect.

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FIG. 611. — SCHENLEY HIGH SCHOOL, GROUND FLOOR PLAN, PITTSBURGH, PENNSYLVANIA.

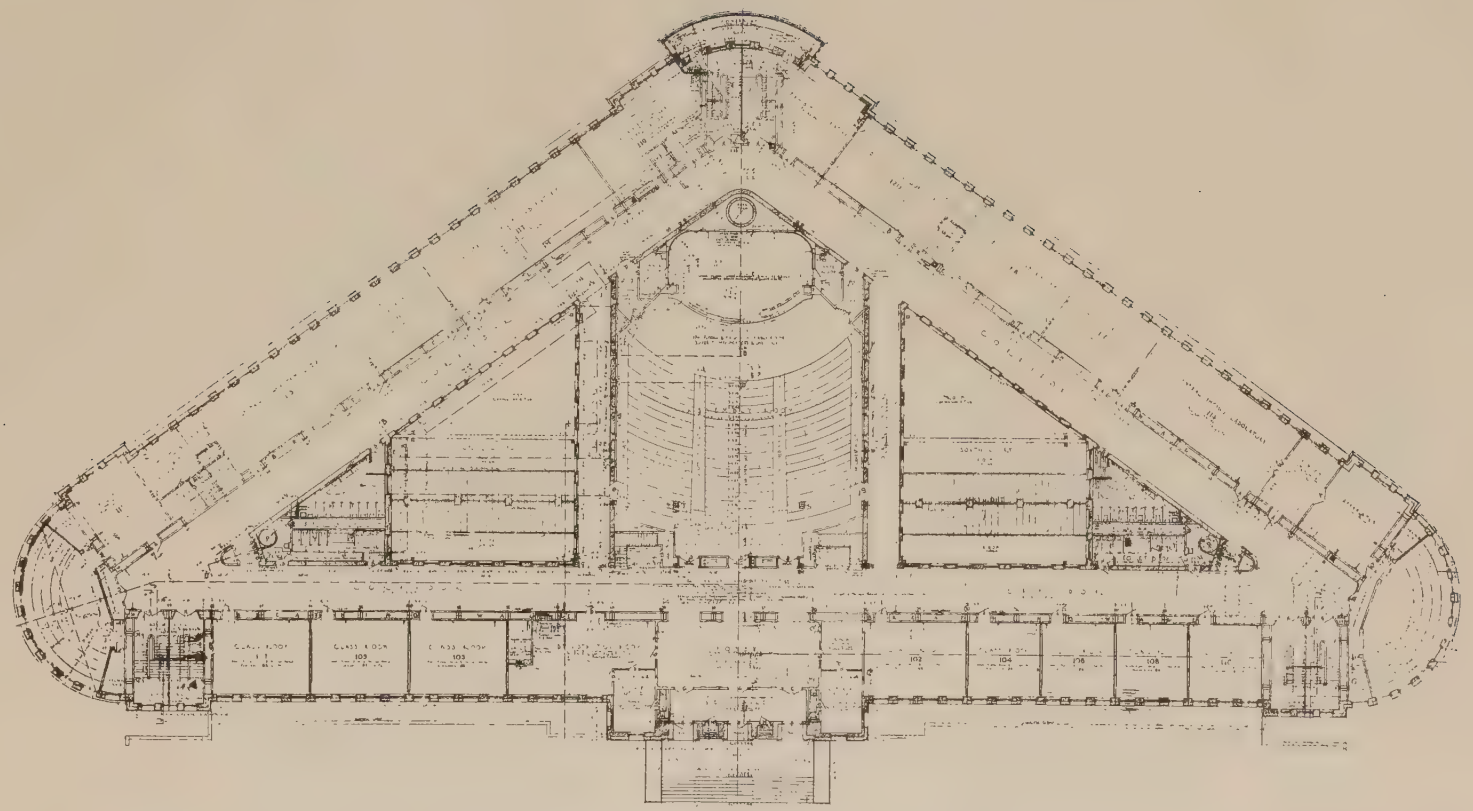

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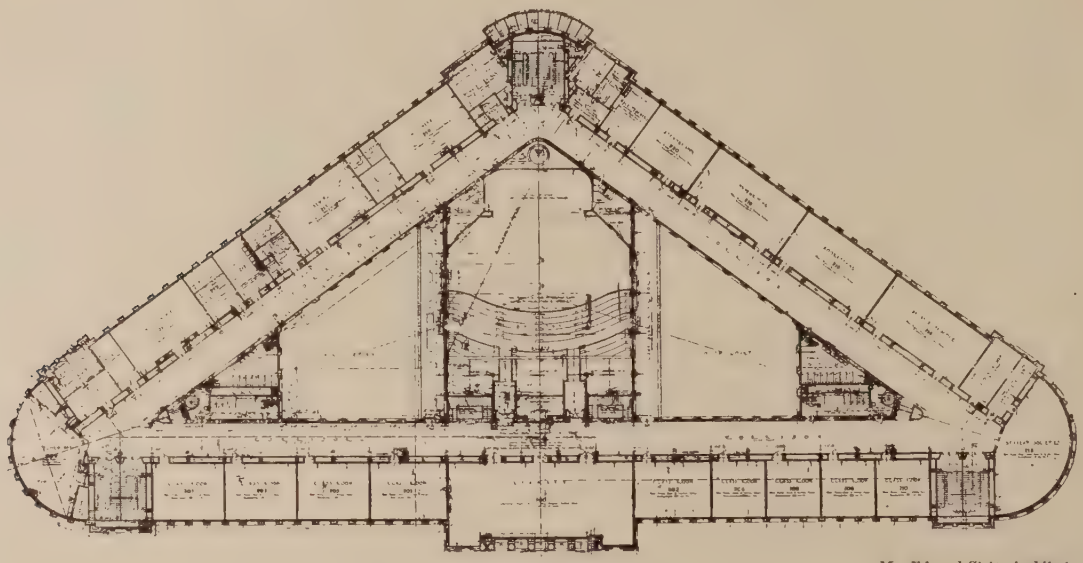
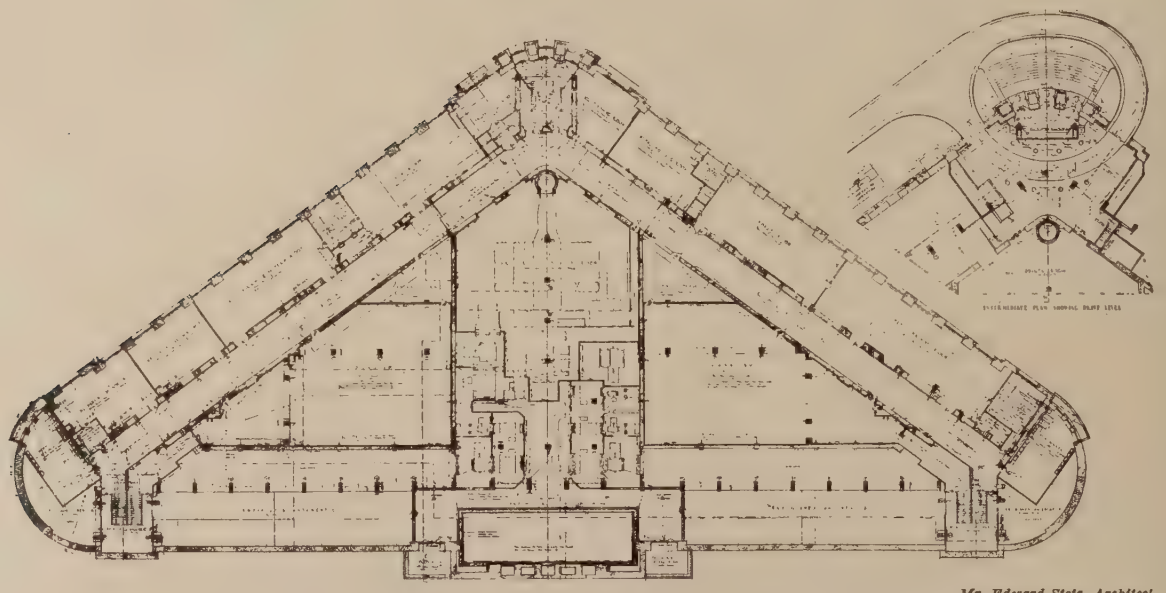
FIG. 612. — SCHENLEY HIGH SCHOOL, FIRST FLOOR PLAN, PITTSBURGH, PENNSYLVANIA.

Mr. Edward Stotz, Architect.



Mr. Edward Stotz, Architect.

FIG. 613. — SCHENLEY HIGH SCHOOL, THIRD FLOOR PLAN, PITTSBURGH, PENNSYLVANIA.



Mr. Edward Stotz, Architect.

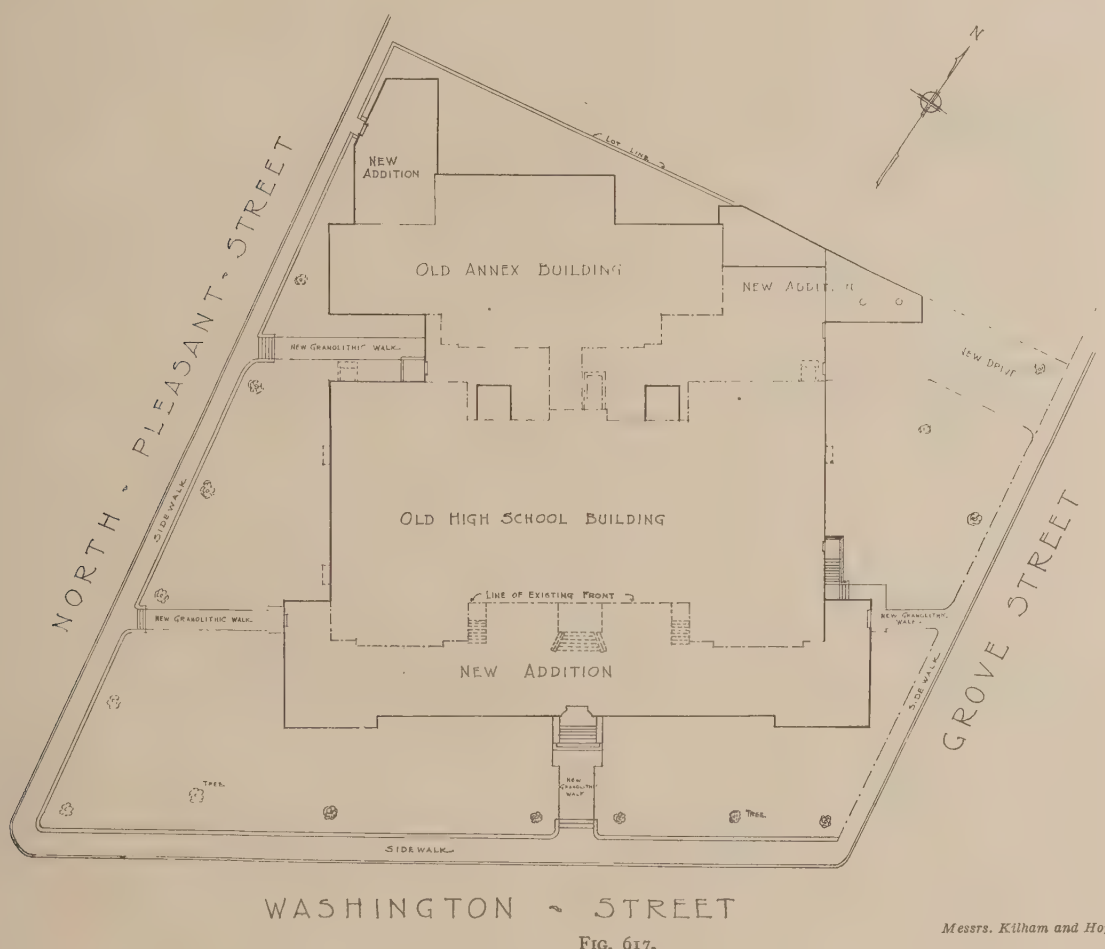
FIG. 614. — SCHENLEY HIGH SCHOOL, BASEMENT FLOOR PLAN, PITTSBURGH, PENNSYLVANIA.

Messrs. Kilnam and Hopkins, Architects.

FIG. 615. — TAUNTON HIGH SCHOOL, TAUNTON, MASSACHUSETTS.

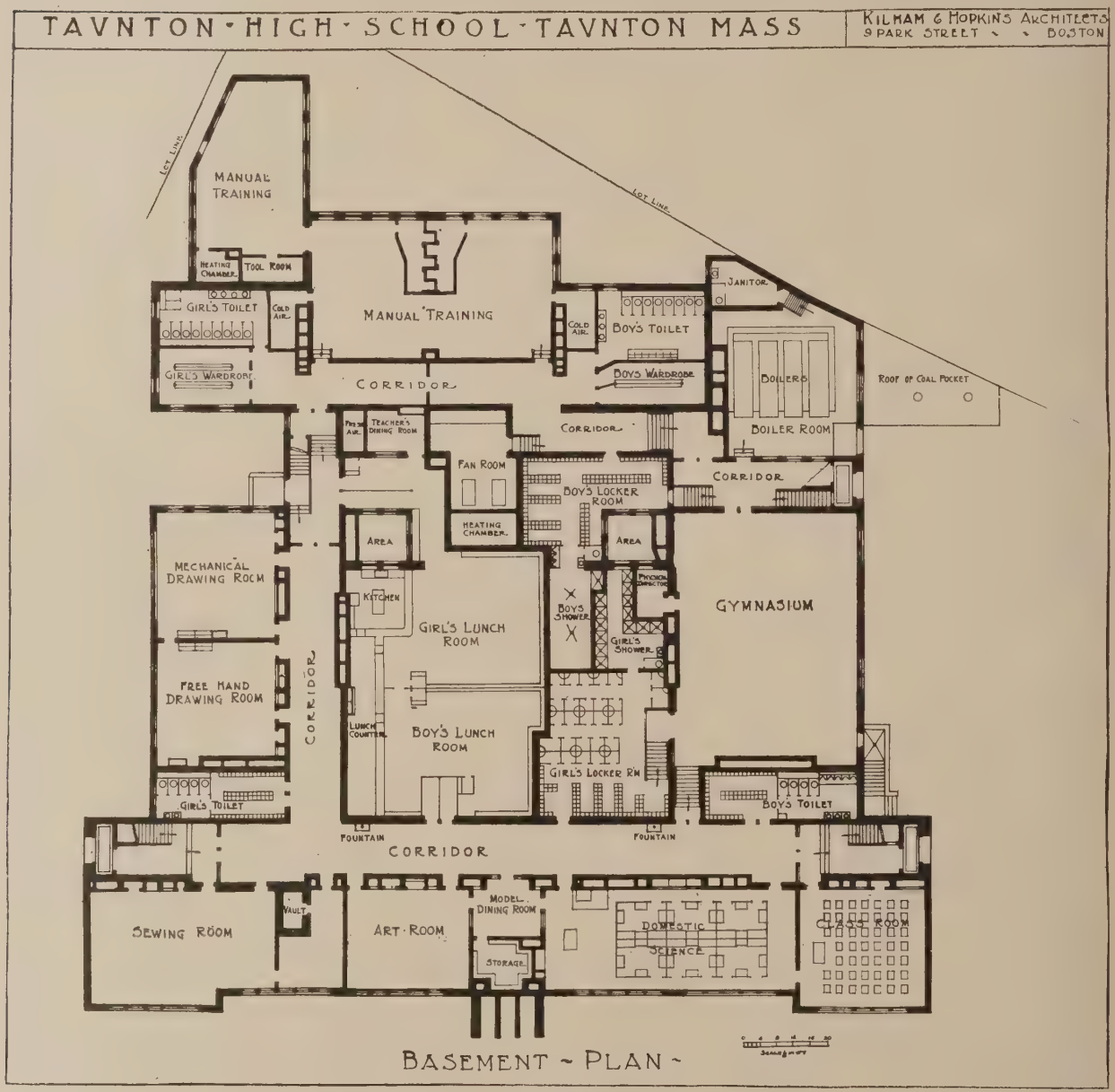
Messrs. Kilham and Hopkins, Architects.

FIG. 616. — TAUNTON HIGH SCHOOL, TAUNTON, MASSACHUSETTS.



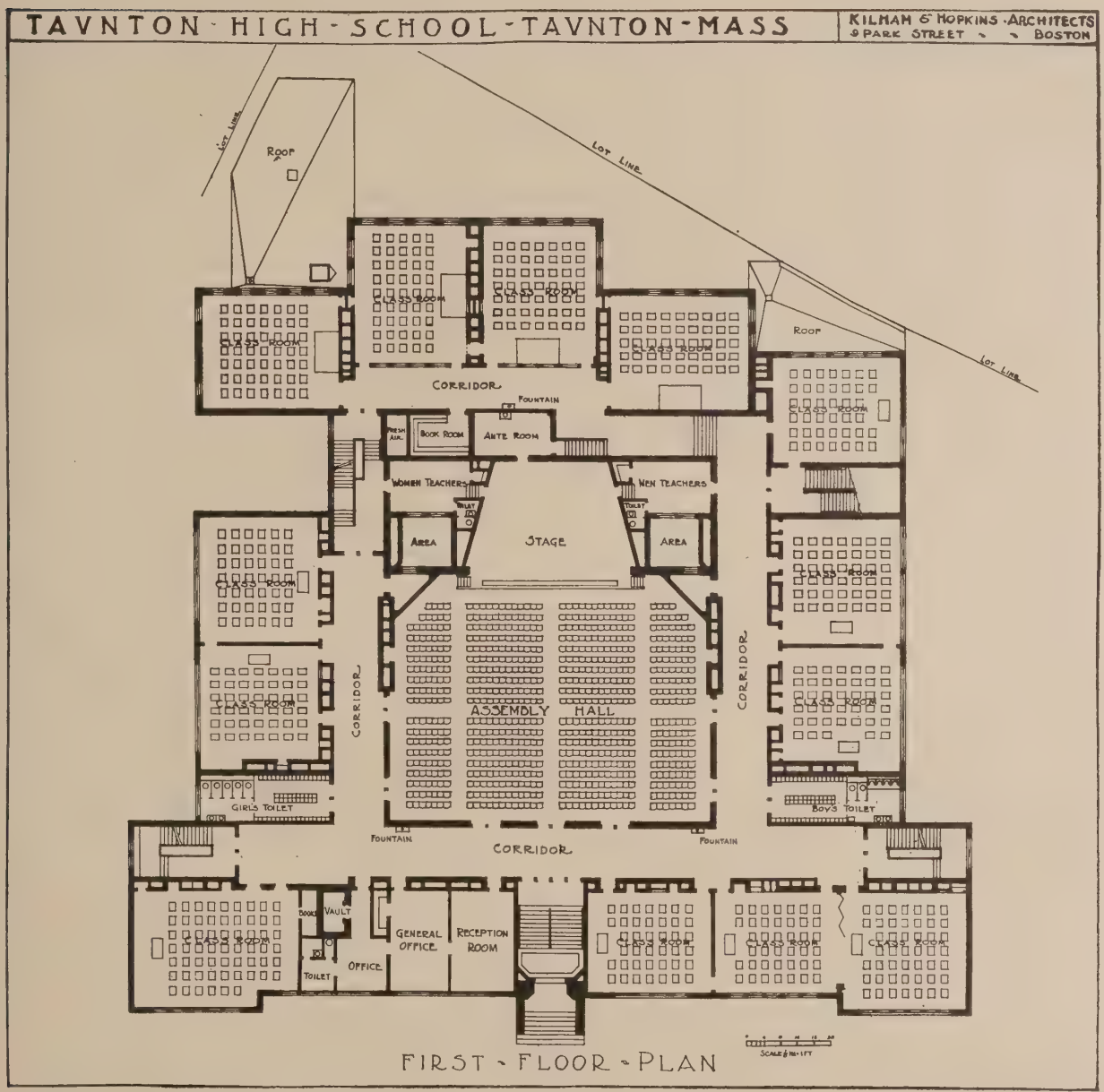
Messrs. Kilham and Hopkins, Architects.

FIG. 617.



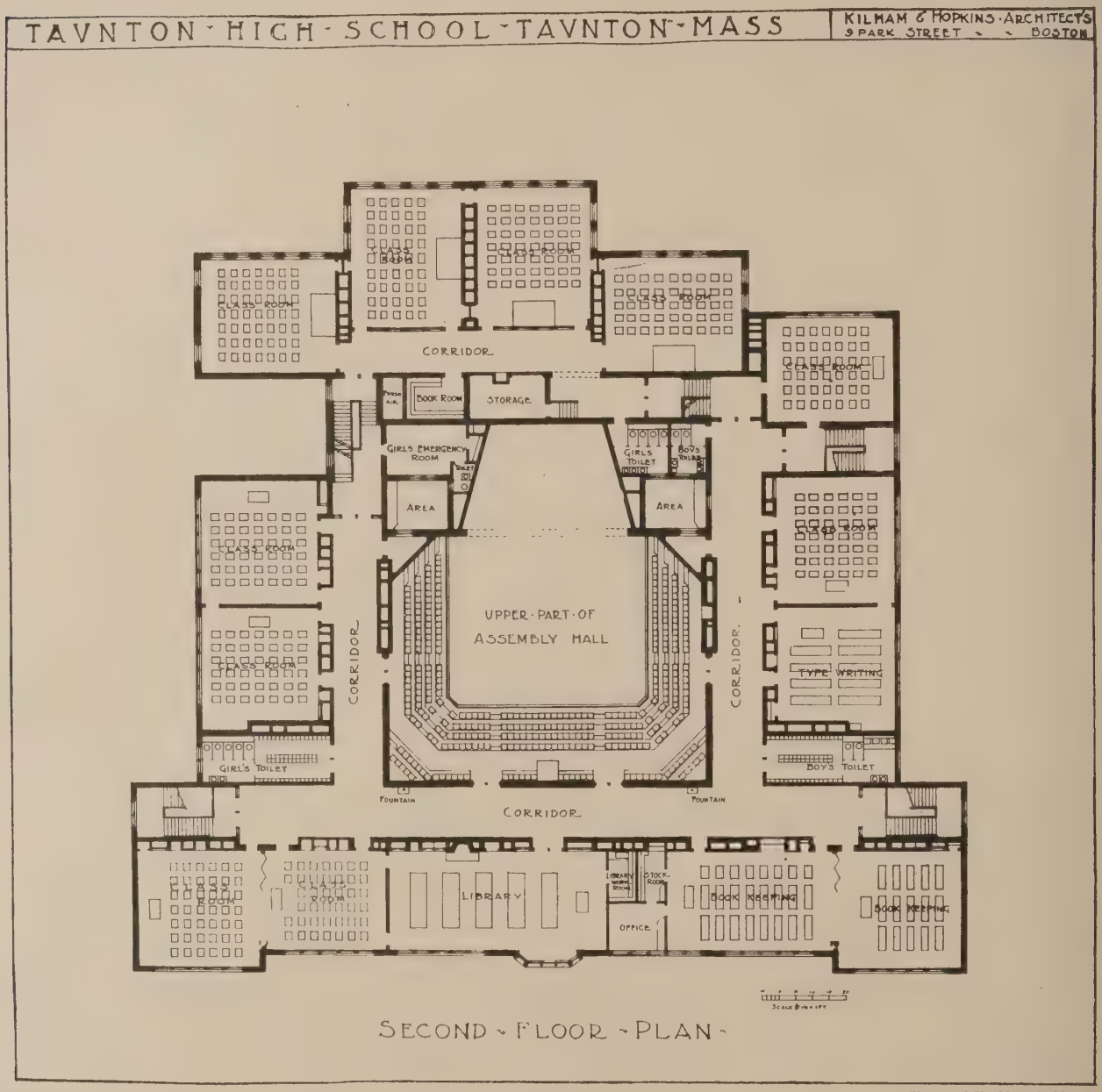
Messrs. Kilham and Hopkins, Architects.

FIG. 618.



Messrs. Kilham and Hopkins, Architects.

FIG. 619.



Messrs. Kilham and Hopkins, Architects.

FIG. 620.

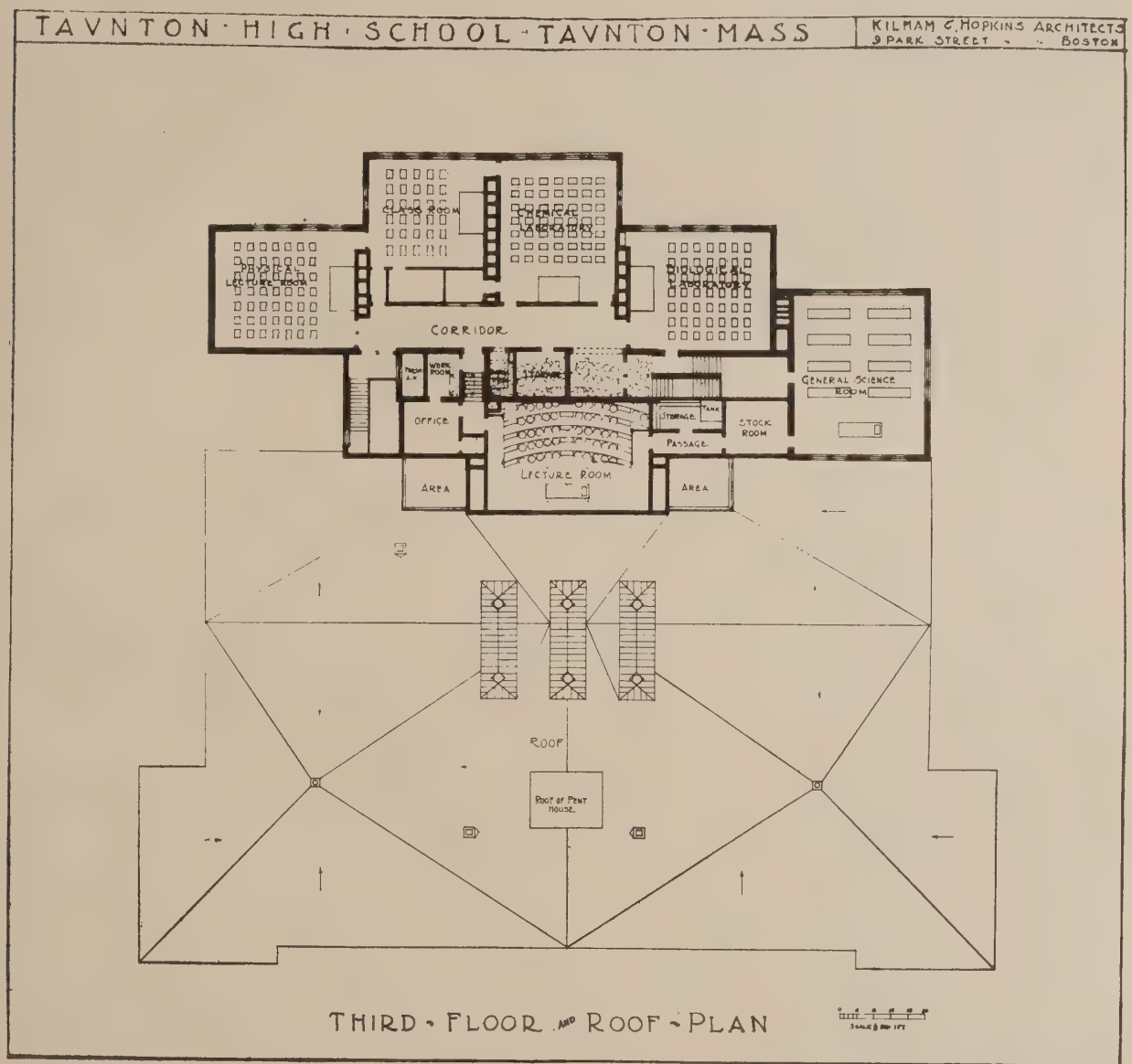
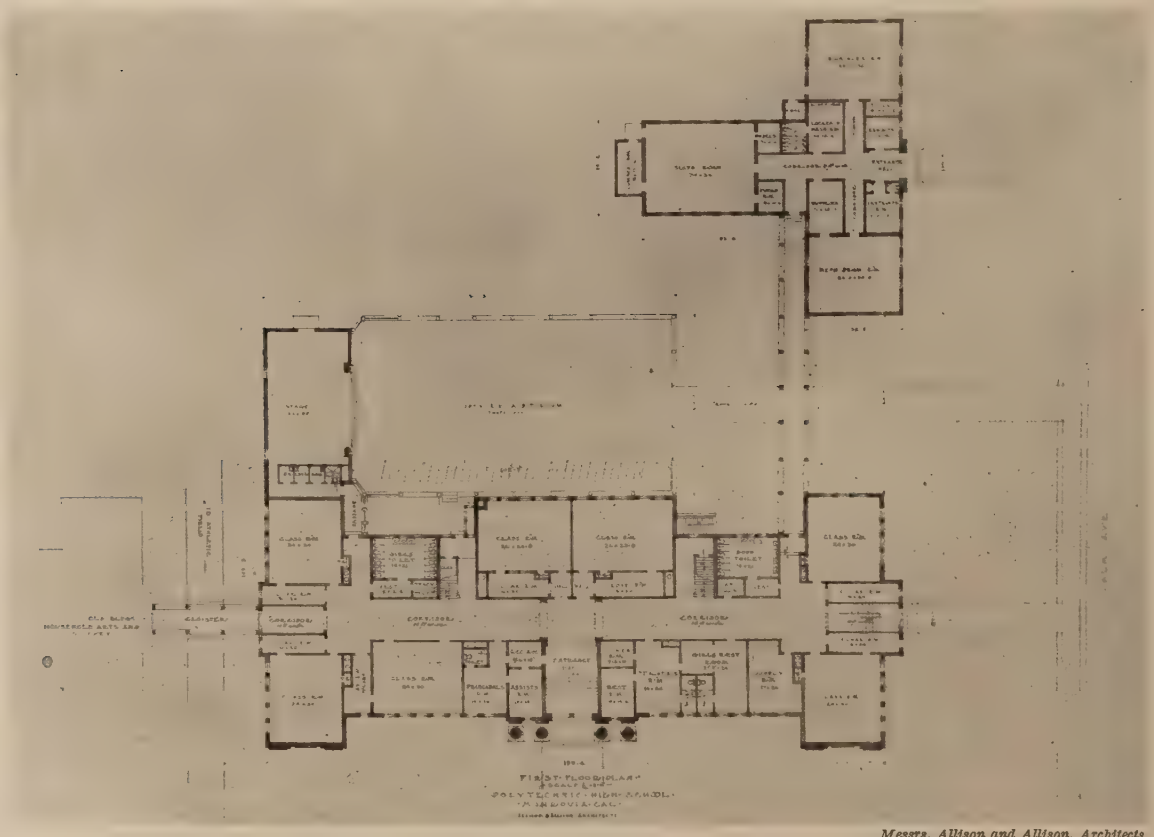


FIG. 621.

Messrs. Kilham and Hopkins, Architects.

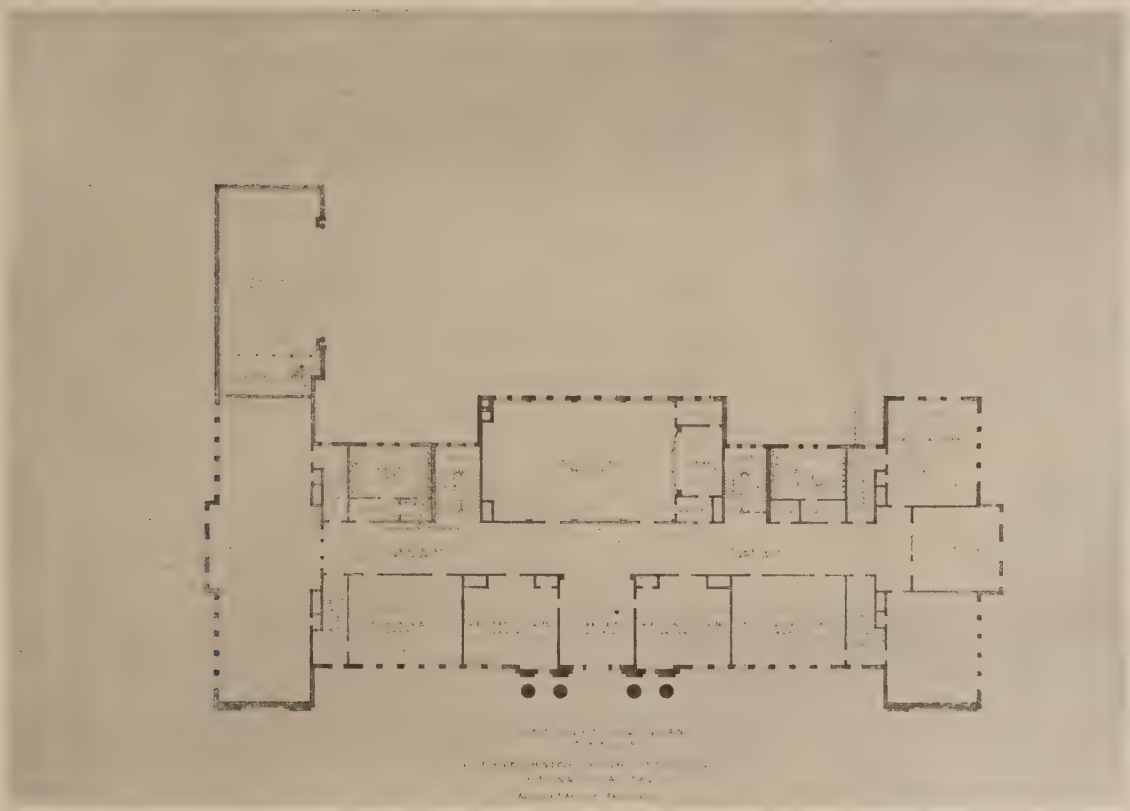
Messrs. Allison and Allison, Architects.

FIG. 622. — POLYTECHNIC HIGH SCHOOL, MONROVIA, CALIFORNIA.



Messrs. Allison and Allison, Architects.

FIG. 623. — POLYTECHNIC HIGH SCHOOL, FIRST FLOOR PLAN, MONROVIA, CALIFORNIA.

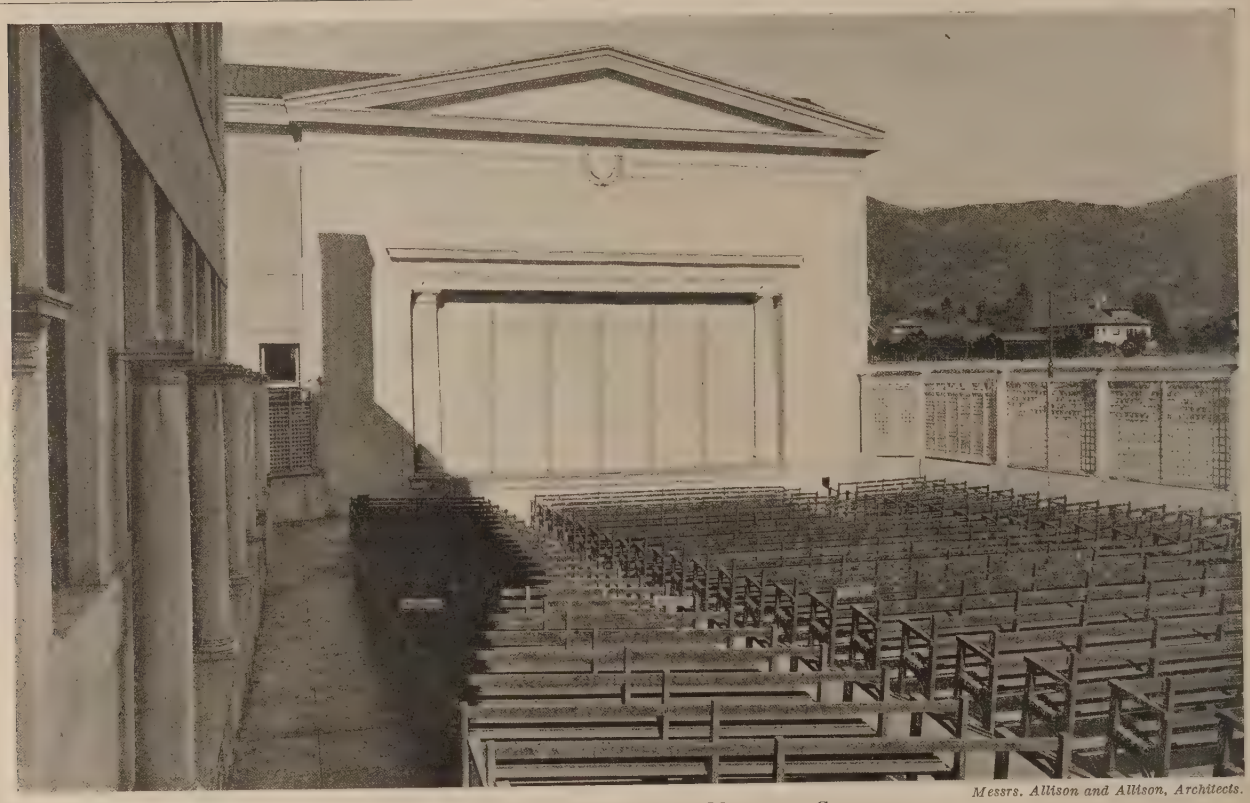


Messrs. Allison and Allison, Architects.

FIG. 624. — POLYTECHNIC HIGH SCHOOL, SECOND FLOOR PLAN, MONROVIA, CALIFORNIA.

Messrs. Allison and Allison, Architects.

FIG. 625. — POLYTECHNIC HIGH SCHOOL, MONROVIA, CALIFORNIA.



Messrs. Allison and Allison, Architects.

FIG. 626. — POLYTECHNIC HIGH SCHOOL, MONROVIA, CALIFORNIA.

Messrs. Allison and Allison, Architects.

FIG. 627. — HIGH SCHOOL, SANTA MONICA, CALIFORNIA.

Messrs. Allison and Allison, Architects.

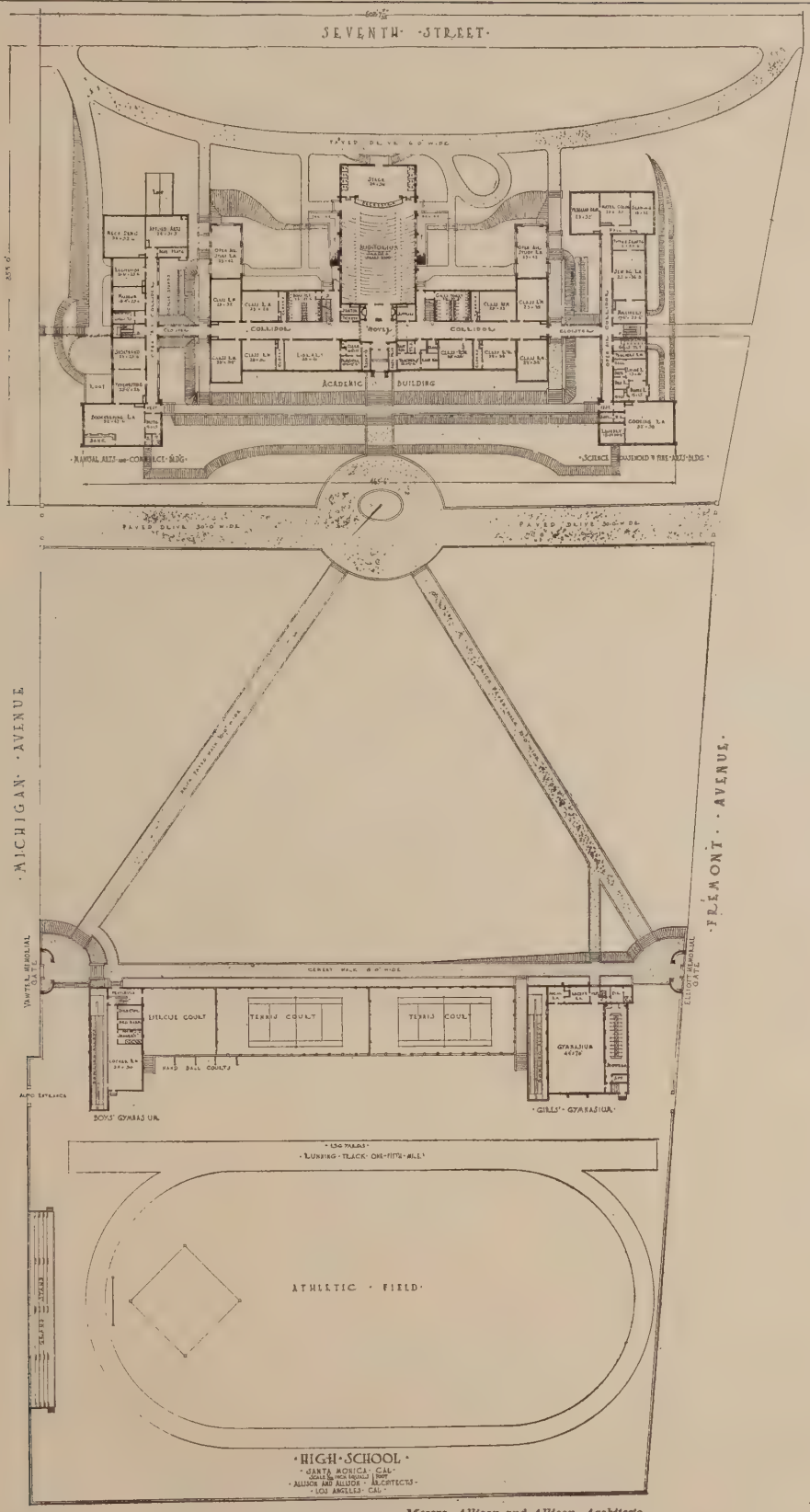
FIG. 628. — HIGH SCHOOL, SANTA MONICA, CALIFORNIA.

Messrs. Allison and Allison, Architects.

FIG. 629. — HIGH SCHOOL, SANTA MONICA, CALIFORNIA.

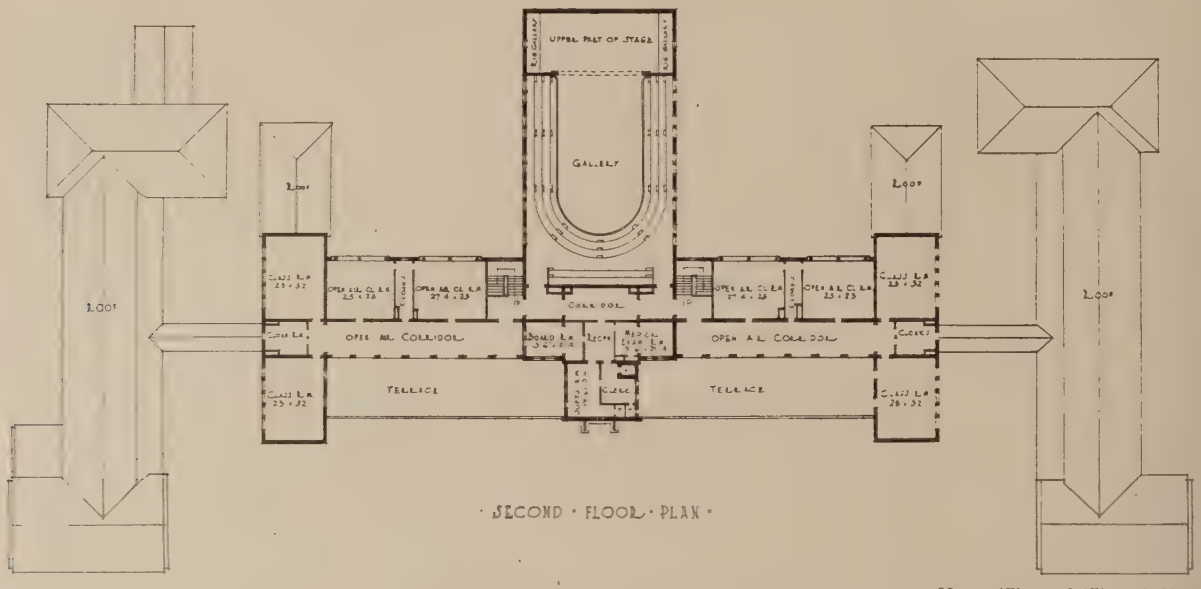
Messrs. Allison and Allison, Architects.

FIG. 630. — HIGH SCHOOL, SANTA MONICA, CALIFORNIA.



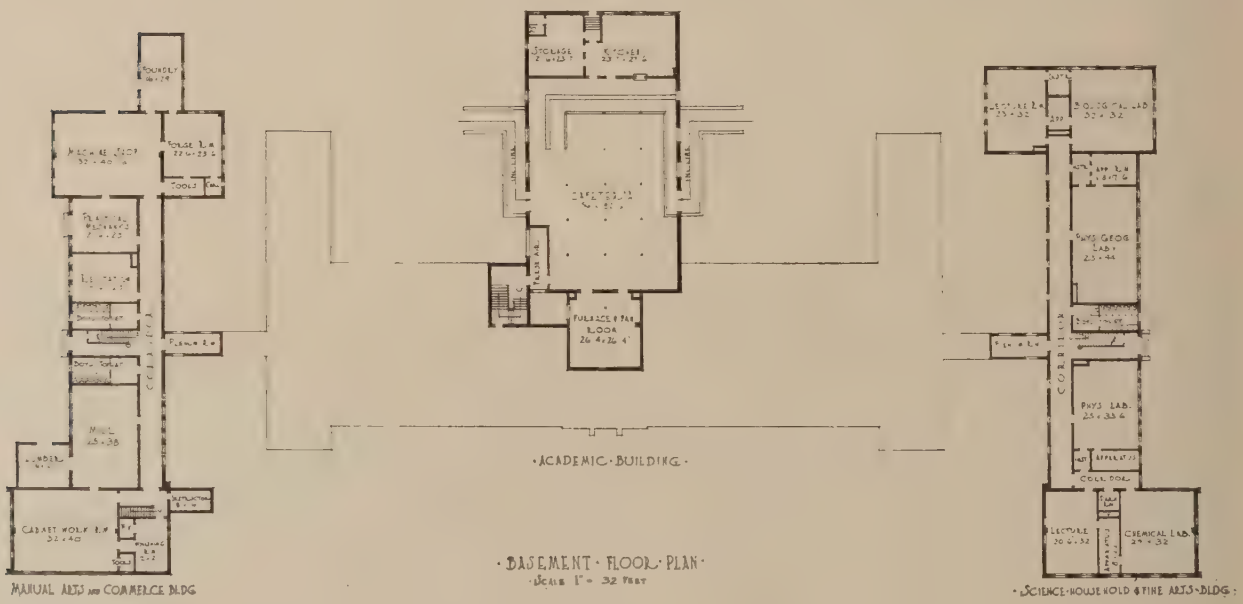
Messrs. Allison and Allison, Architects.

FIG. 631. — HIGH SCHOOL, SANTA MONICA, CALIFORNIA.



Messrs. Allison and Allison, Architects.

FIG. 632. — HIGH SCHOOL, SECOND FLOOR PLAN, SANTA MONICA, CALIFORNIA.



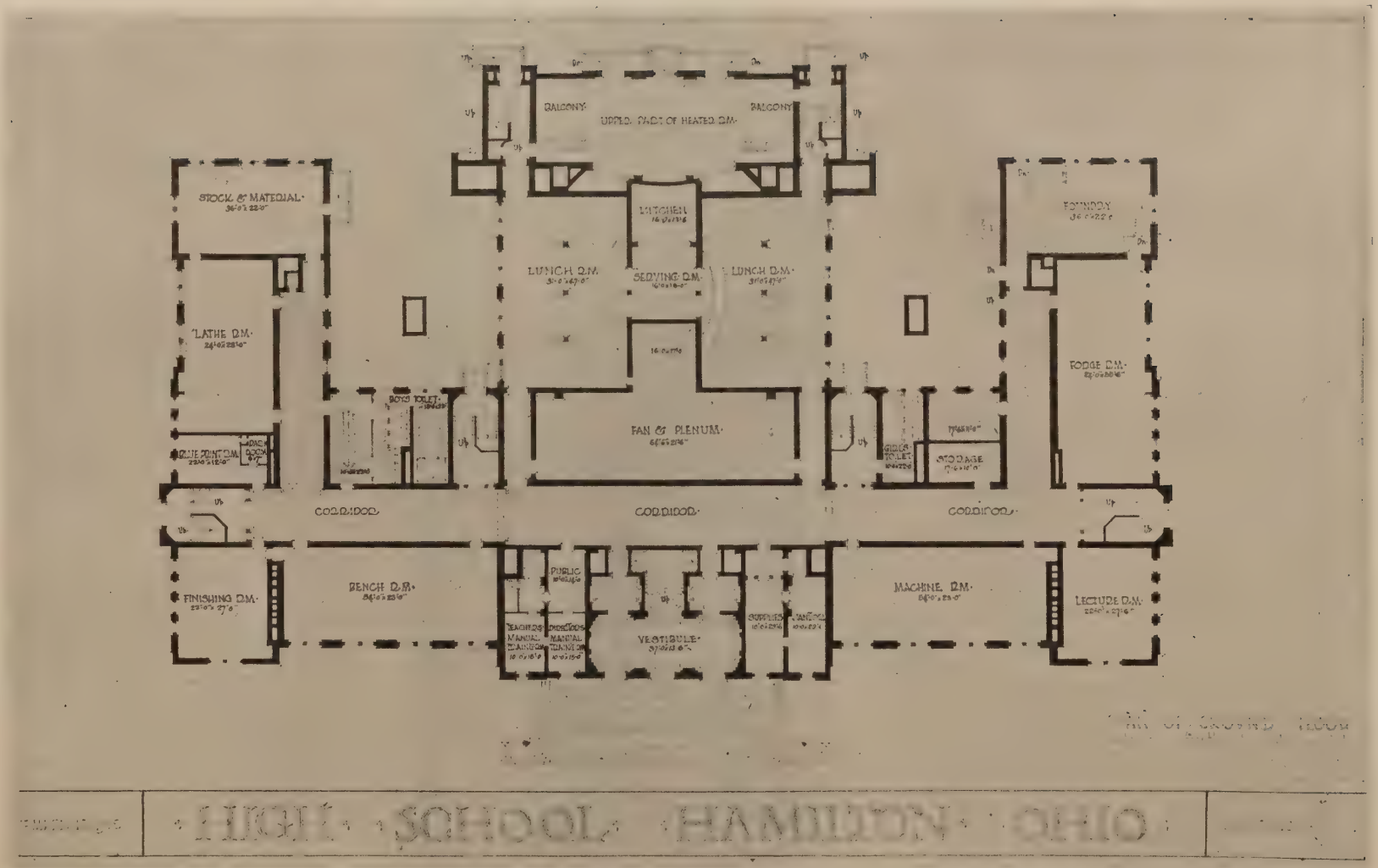
· HIGH · SCHOOL ·
SANTA MONICA · CAL.
· ALLISON AND ALLISON · ARCHITECTS ·
· LOS ANGELES · CAL ·

Messrs. Allison and Allison, Architects.

FIG. 633. — HIGH SCHOOL, BASEMENT FLOOR PLAN, SANTA MONICA, CALIFORNIA.

Mr. Frank L. Packard and Mr. Frederick G. Mueller, Associate Architects.

FIG. 634. — HIGH SCHOOL, HAMILTON, OHIO.



Mr. Frank L. Packard and Mr. Frederick G. Mueller, Associate Architects.

FIG. 635.

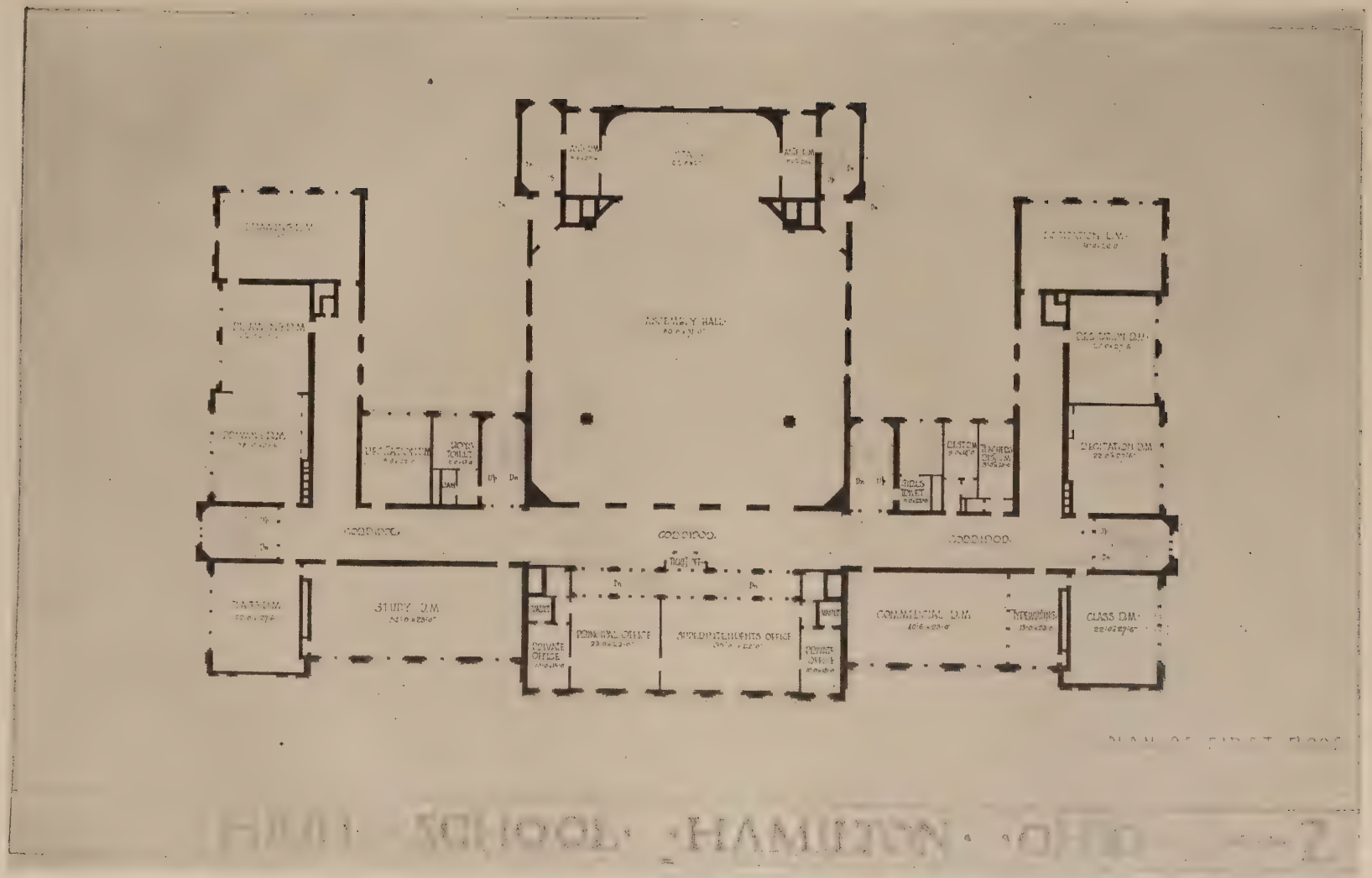
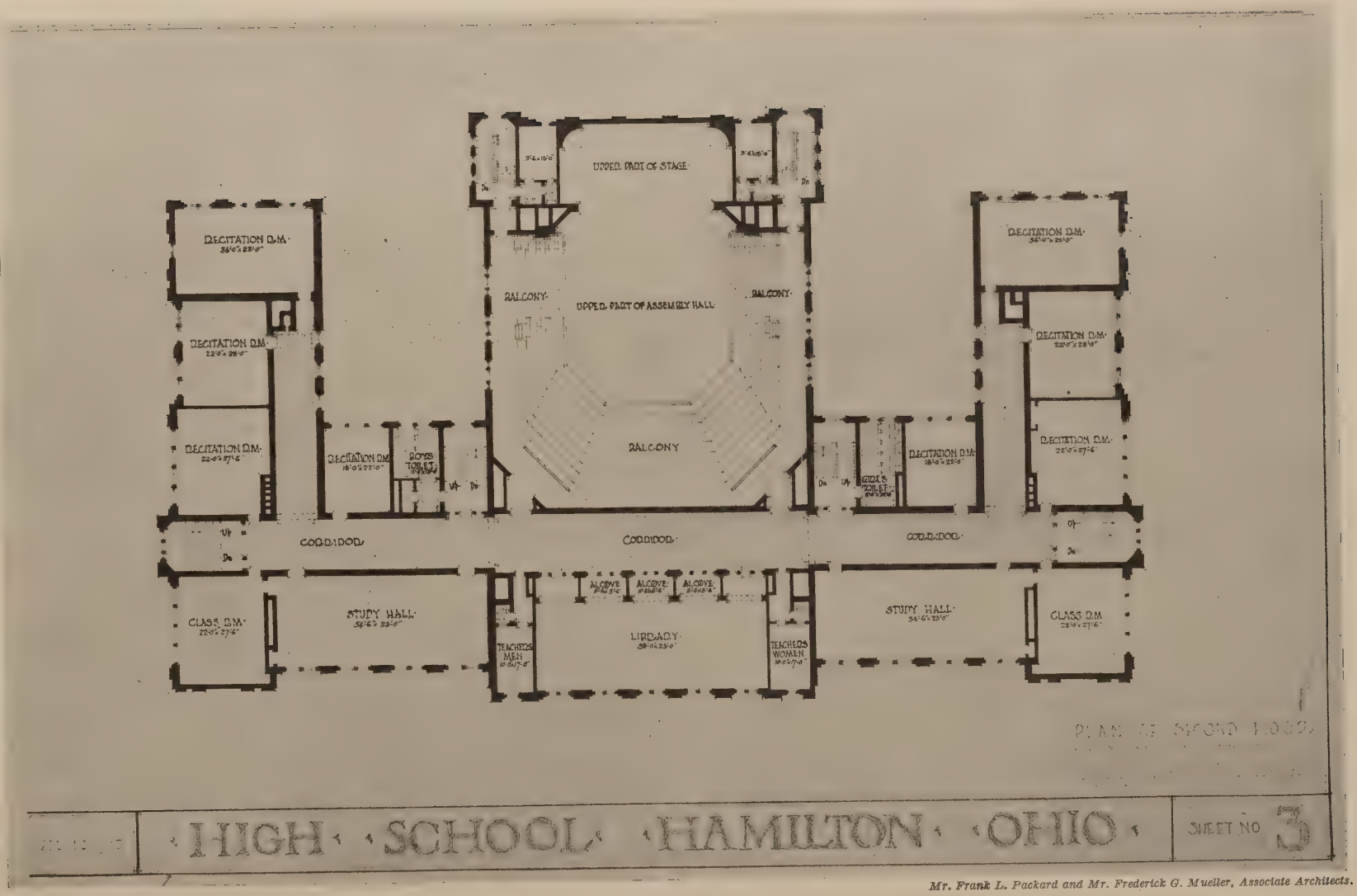


FIG. 636.

Mr. Frank L. Packard and Mr. Frederick G. Mueller, Associate Architects.



Mr. Frank L. Packard and Mr. Frederick G. Mueller, Associate Architects.

FIG. 637.

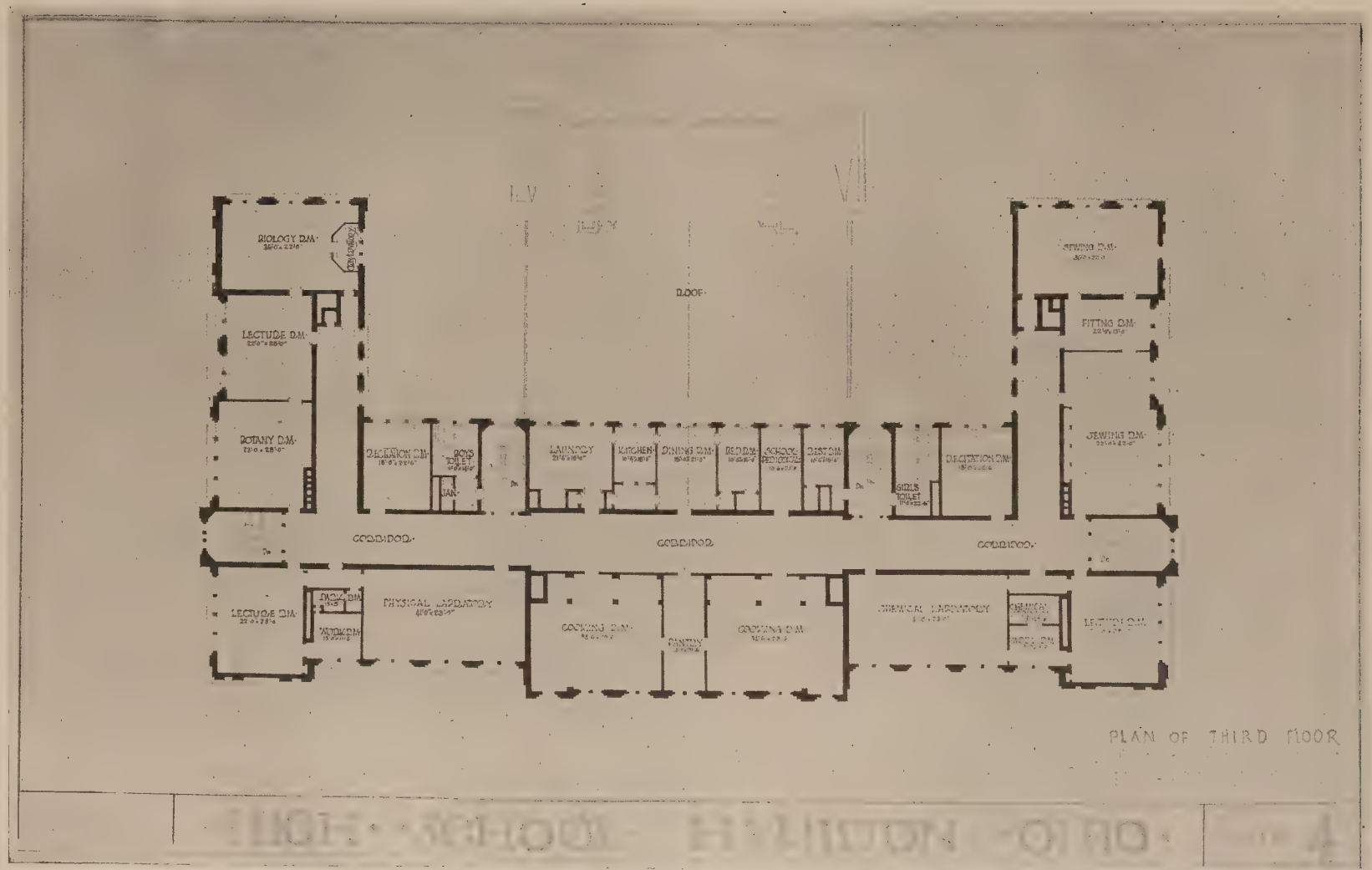


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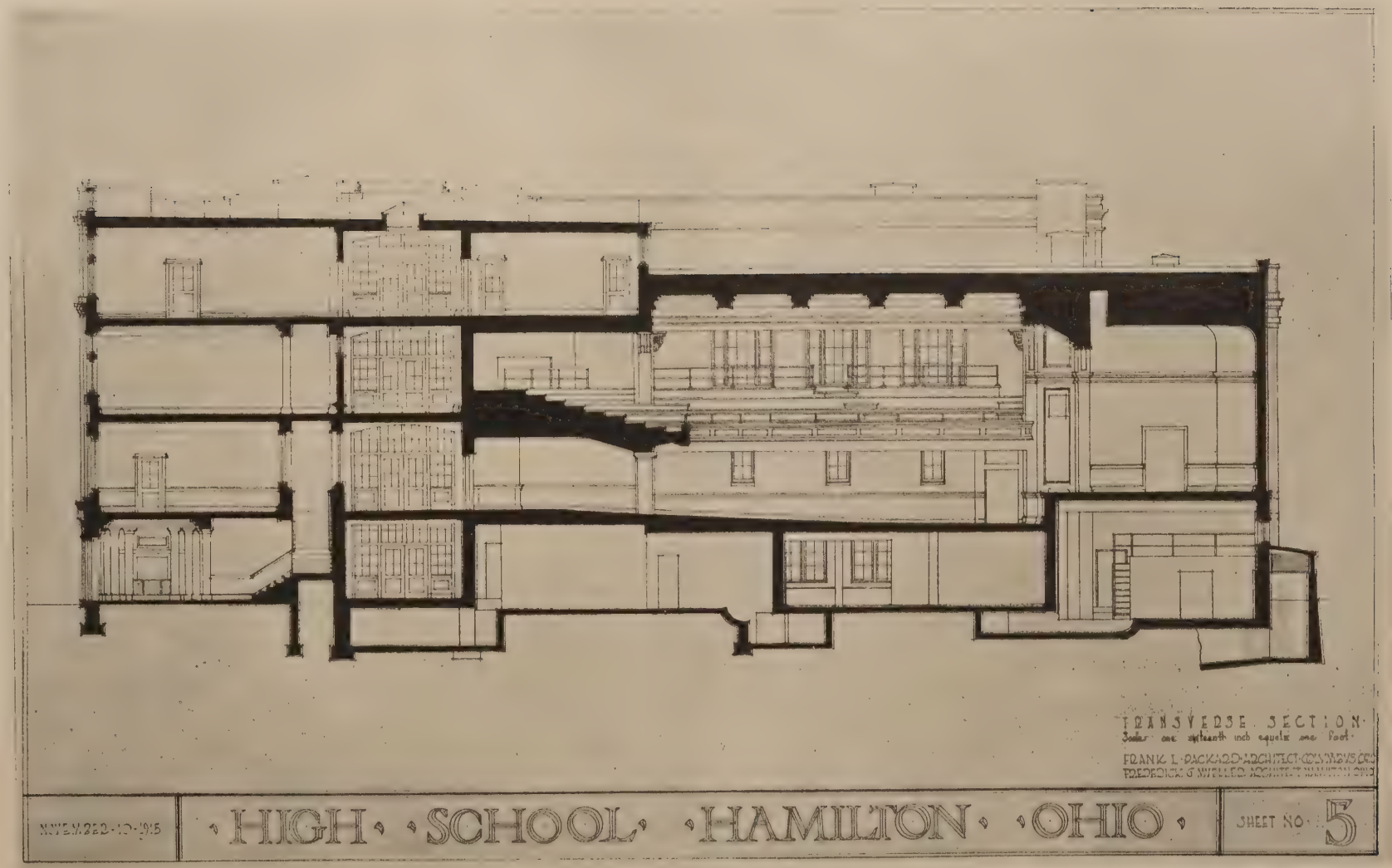
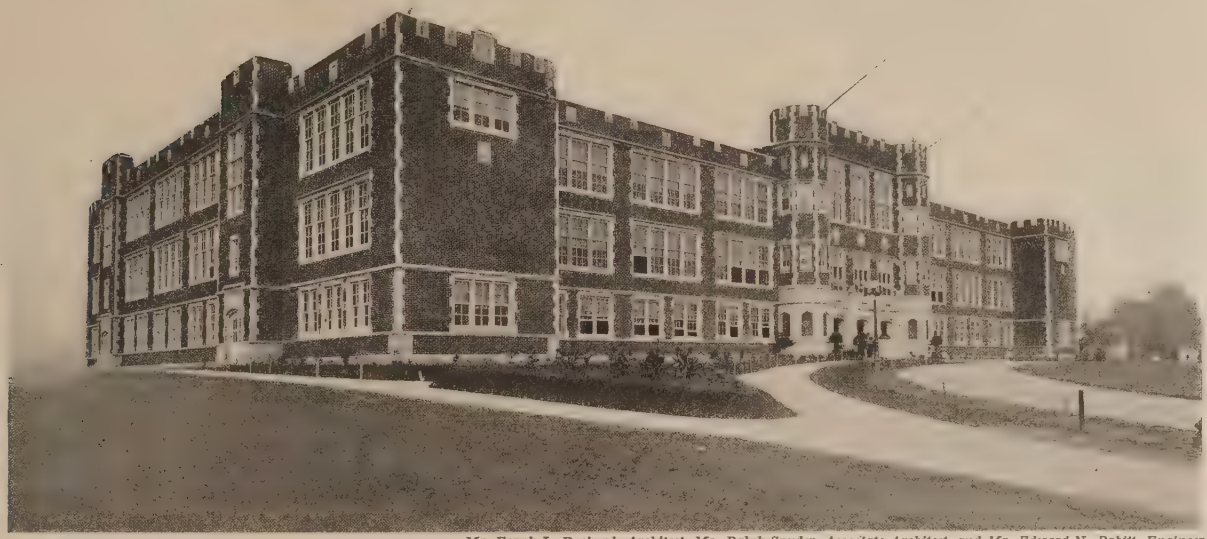
FIG. 638.

Mr. Frank L. Packard and Mr. Frederick G. Mueller, Associate Architects.


TRANSVERSE SECTION
Scale: one sixteenth inch equals one foot
FRANK L. PACKARD ARCHITECT
HIGH SCHOOL HAMILTON OHIO
SHEET NO. 5

Mr. Frank L. Packard and Mr. Frederick G. Mueller, Associate Architects.

FIG. 639.



Mr. Frank L. Packard, Architect, Mr. Ralph Snyder, Associate Architect, and Mr. Edward N. Babitt, Engineer.

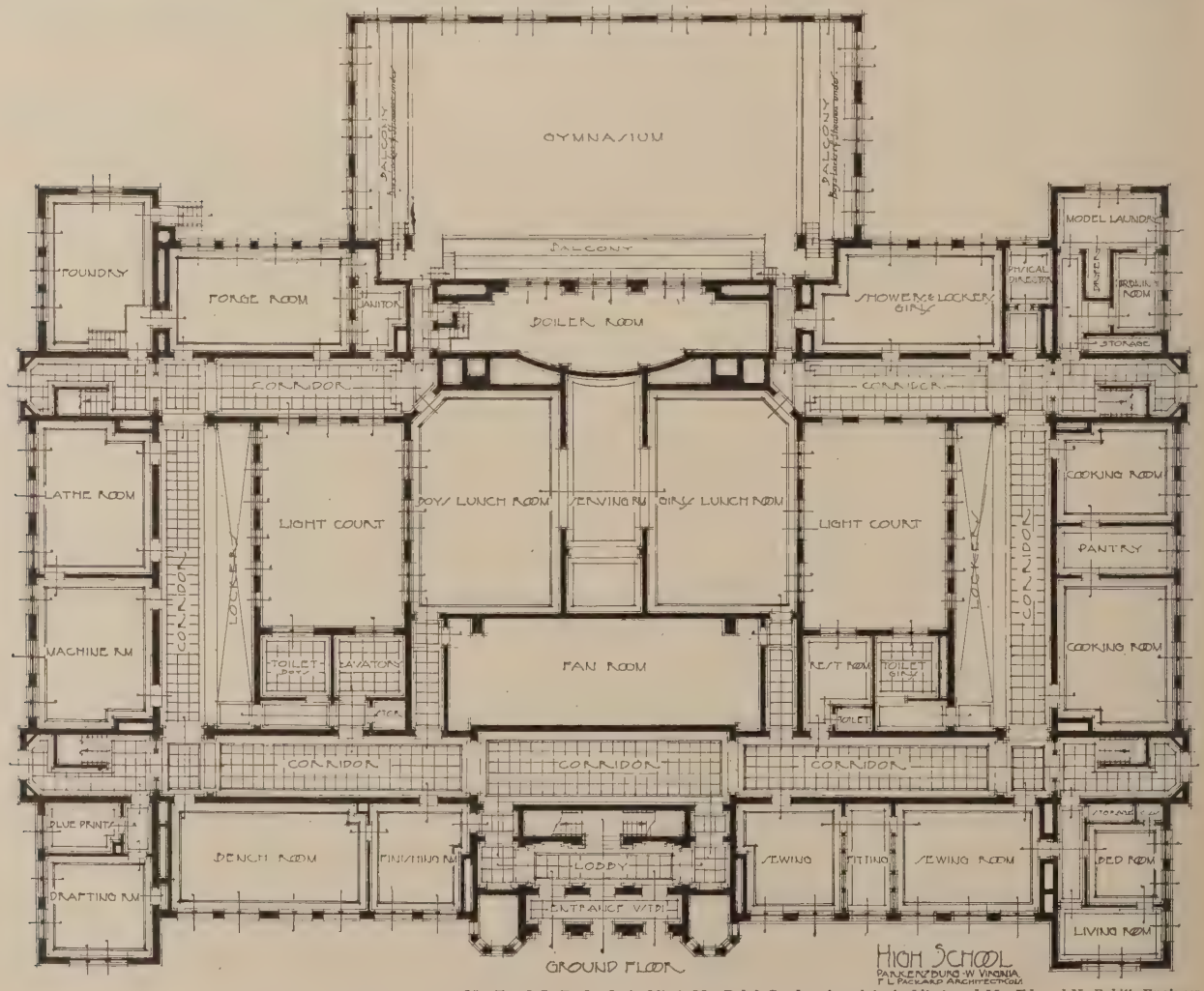
FIG. 640. — HIGH SCHOOL, PARKERSBURG, WEST VIRGINIA.

Mr. Frank L. Packard, Architect, Mr. Ralph Snyder, Associate Architect, and Mr. Edward N. Babitt, Engineer.

FIG. 641. — HIGH SCHOOL, PARKERSBURG, WEST VIRGINIA.

Mr. Frank L. Packard, Architect, Mr. Ralph Snyder, Associate Architect, and Mr. Edward N. Babitt, Engineer.

FIG. 642. — HIGH SCHOOL, PARKERSBURG, WEST VIRGINIA.



Mr. Frank L. Packard, Architect, Mr. Ralph Snyder, Associate Architect, and Mr. Edward N. Babitt, Engineer.

FIG. 643. — HIGH SCHOOL, GROUND FLOOR PLAN, PARKERSBURG, WEST VIRGINIA.

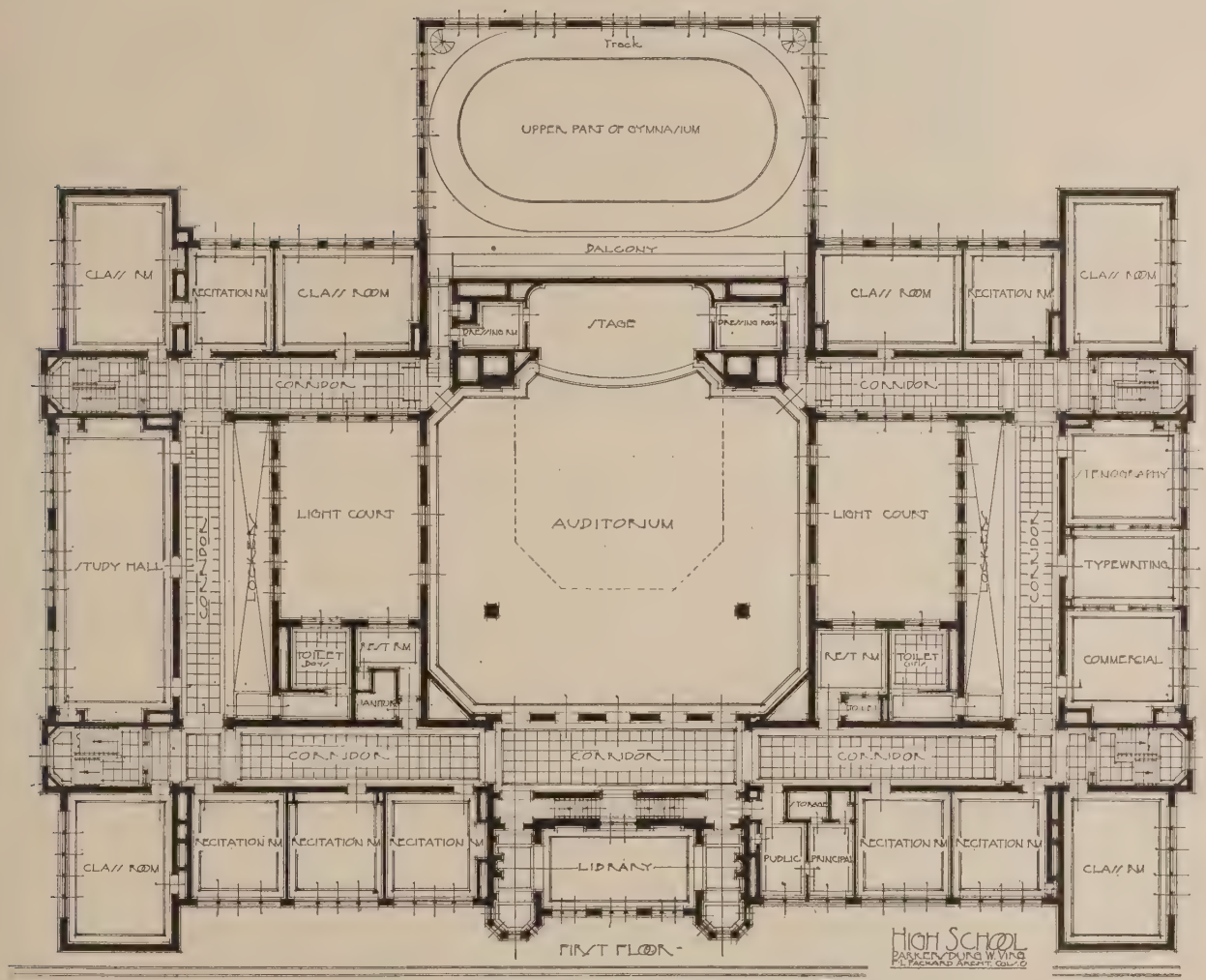


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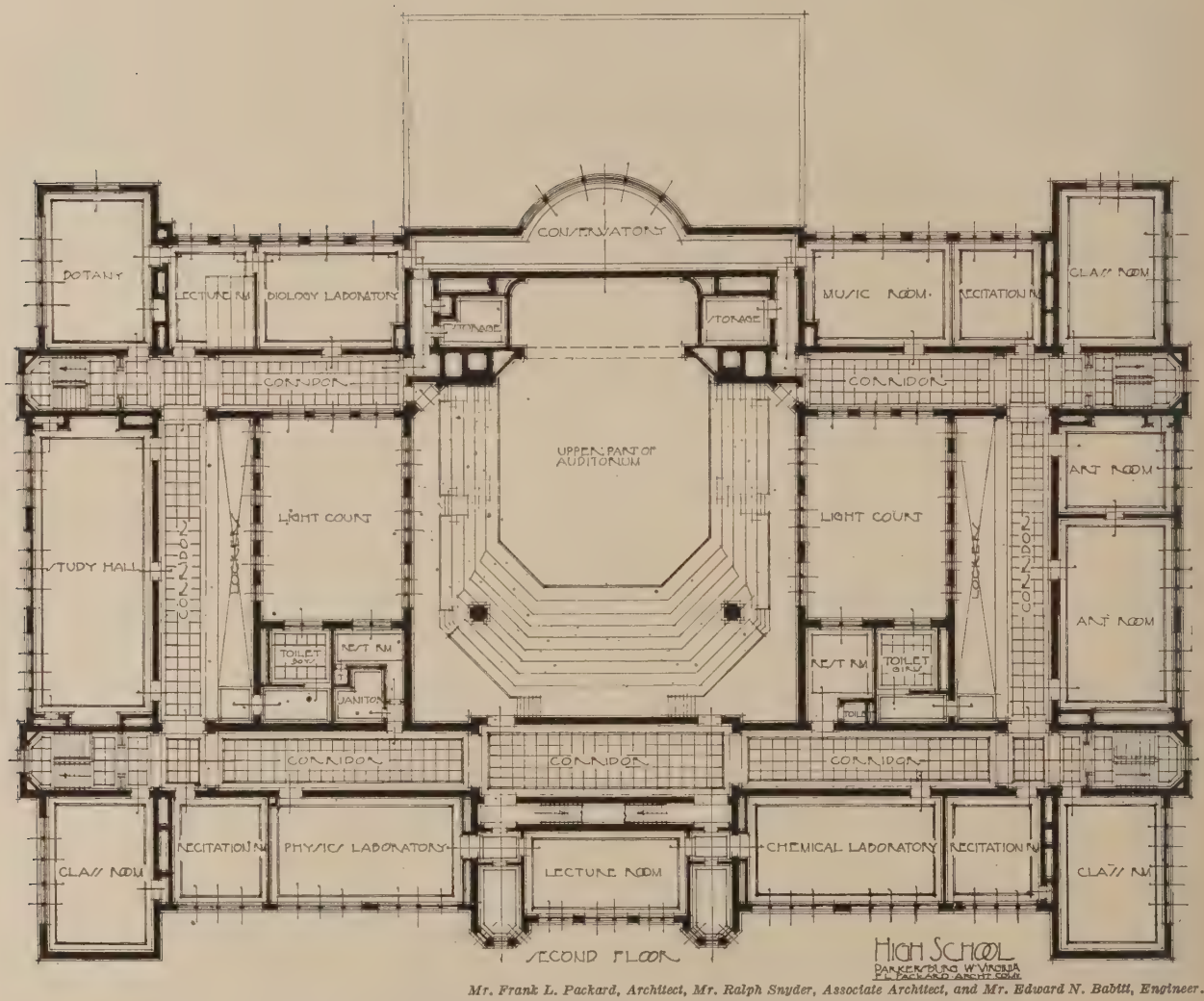
FIG. 644. — HIGH SCHOOL, FIRST FLOOR PLAN, PARKERSBURG, WEST VIRGINIA.



Mr. Frank L. Packard, Architect, Mr. Ralph Snyder, Associate Architect, and Mr. Edward N. Babtt, Engineer.

FIG. 645.—HIGH SCHOOL, SECOND FLOOR PLAN, PARKERSBURG, WEST VIRGINIA.

Fig. 646.

Messrs. Maginnis and Walsh, Architects.

Fig. 647.

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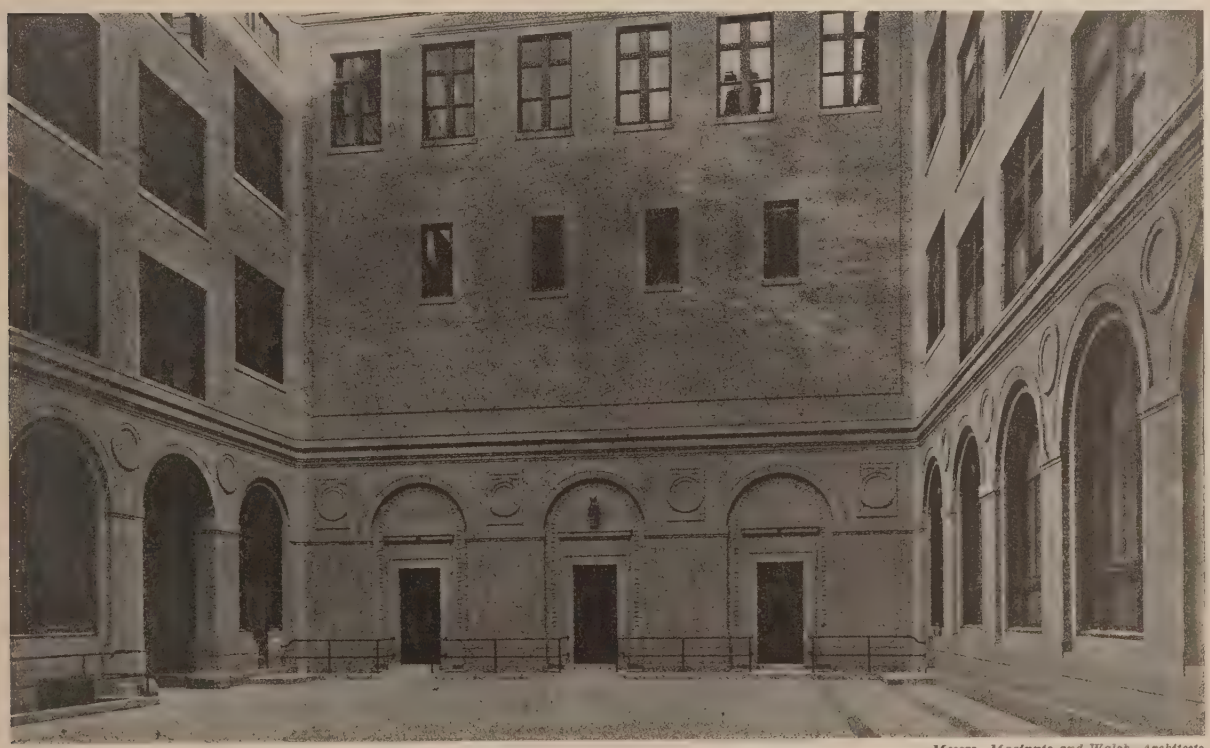
REGIS HIGH SCHOOL, NEW YORK CITY.

Messrs. Maginnis and Walsh, Architects.

FIG. 648. — REGIS HIGH SCHOOL, LOBBY, NEW YORK CITY.

Messrs. Maginnis and Walsh, Architects.

FIG. 649. — REGIS HIGH SCHOOL, MAIN HALL, NEW YORK CITY.



Messrs. Maginnis and Walsh, Architects.

FIG. 650. — REGIS HIGH SCHOOL, NEW YORK CITY.

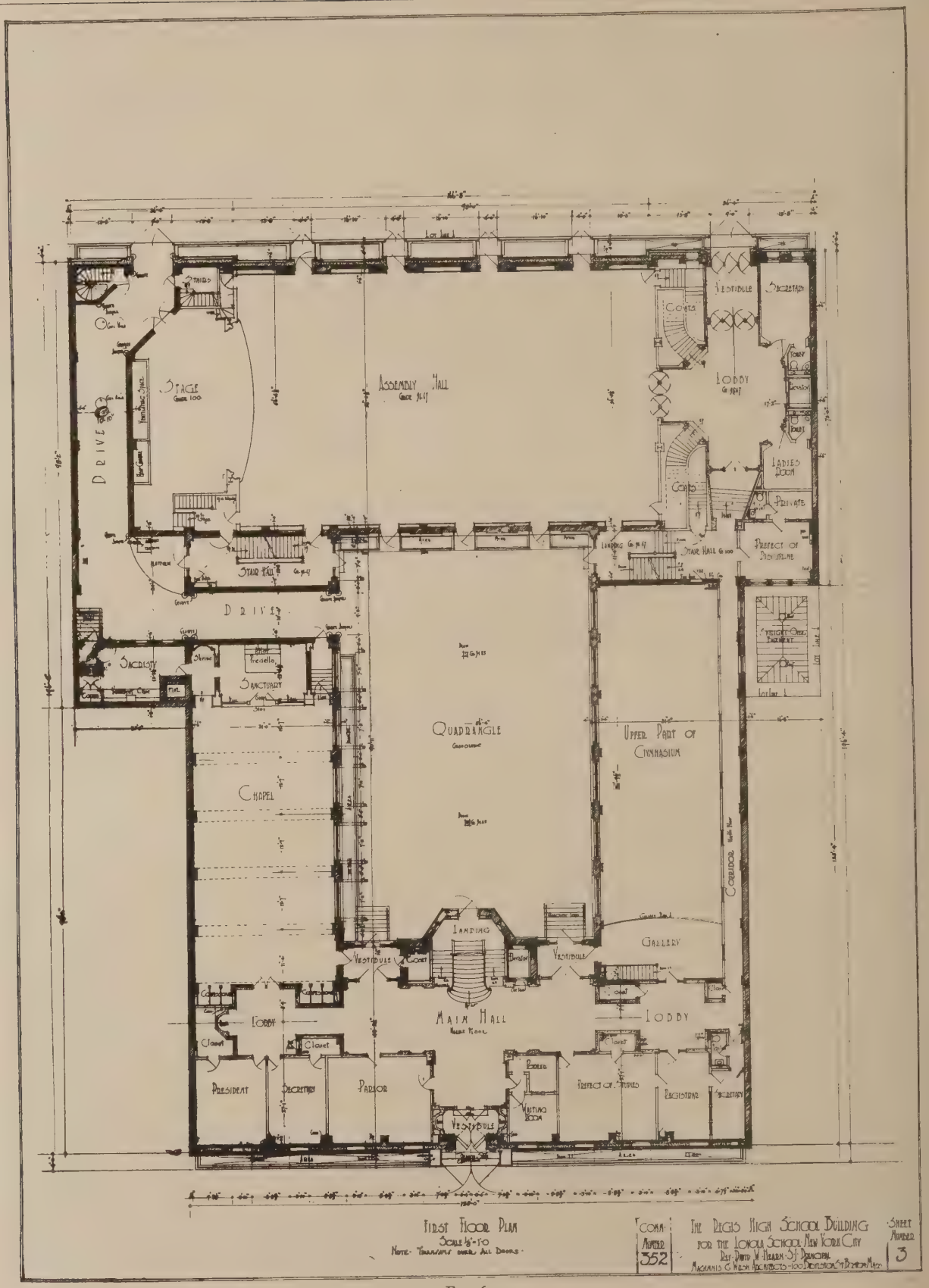
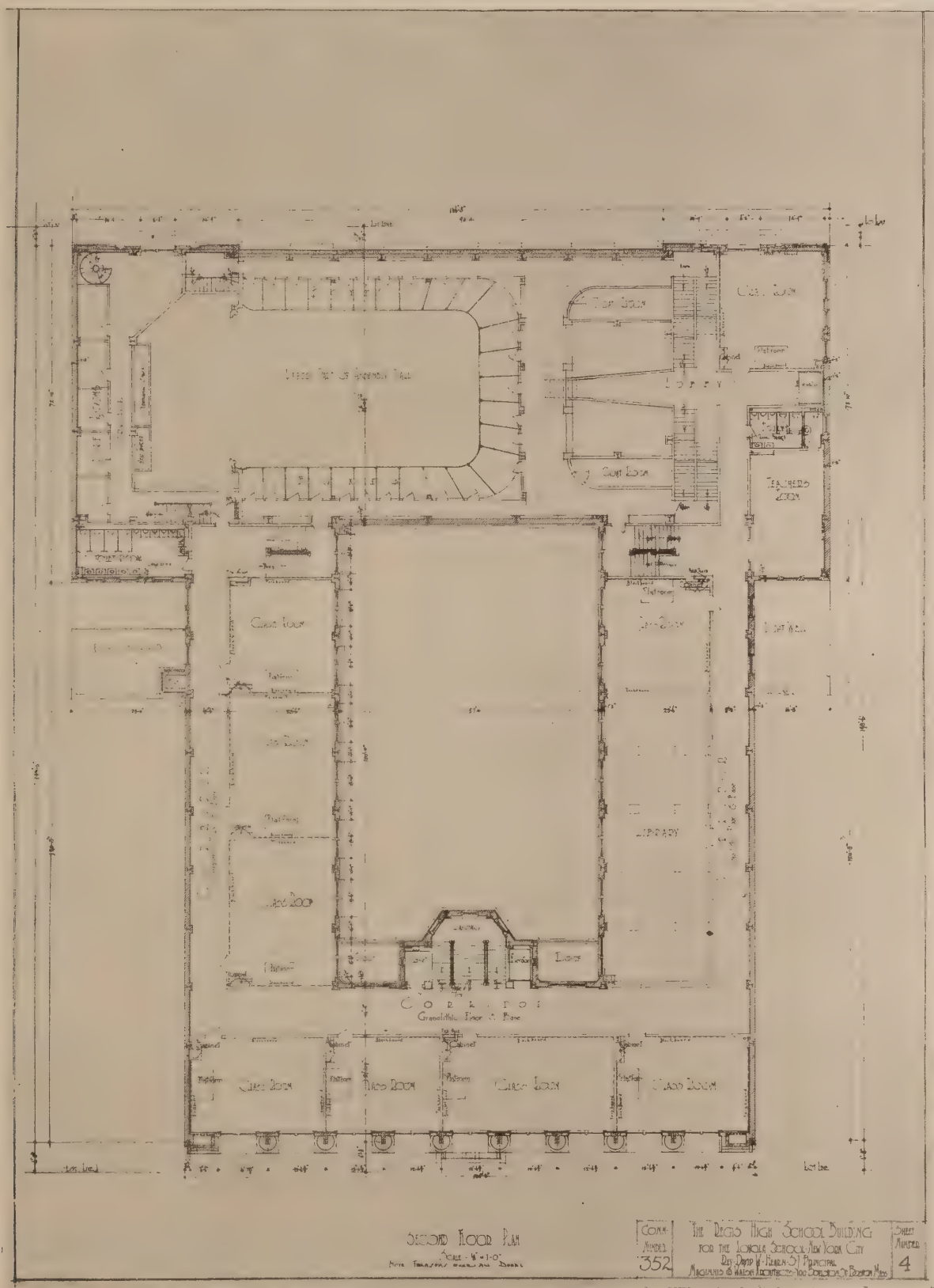
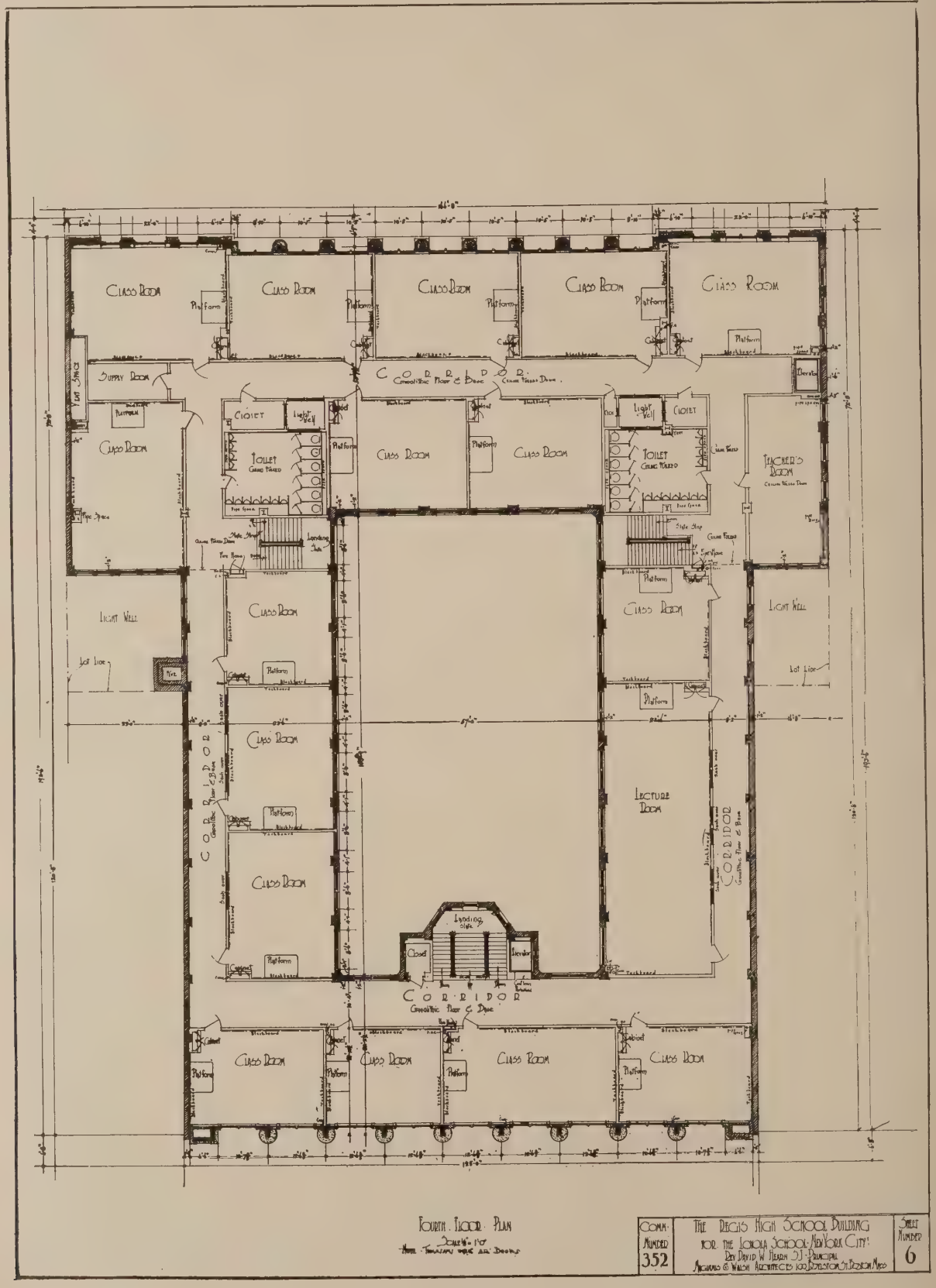

Assembly Hall
Stage
Drive
Vestibule
Secretary
Lobby
Coats
Ladies Room
Private
Prefect of Discipline
Stair Hall
Sacristy
Sanctuary
Quadrangle
Upper Part of Gymnasium
Chapel
Corridor
Landing
Gallery
Vestibule
Main Hall
Lobby
President
Secretary
Parlor
Waiting Room
Prefect of Studies
Registrar
First Floor Plan
Scale 1/8"-1'-0
Note- Transoms over all Doors.
Contract Number 352
The Regis High School Building for the Loyola School, New York City
Sheet Number 3

FIG. 651.


Class Room
Class Room
Class Room


Class Room
Class Room
Class Room
Class Room
Class Room
Supply Room
Toilet
Light Well
Corridor
Class Room
Class Room
Class Room
Class Room

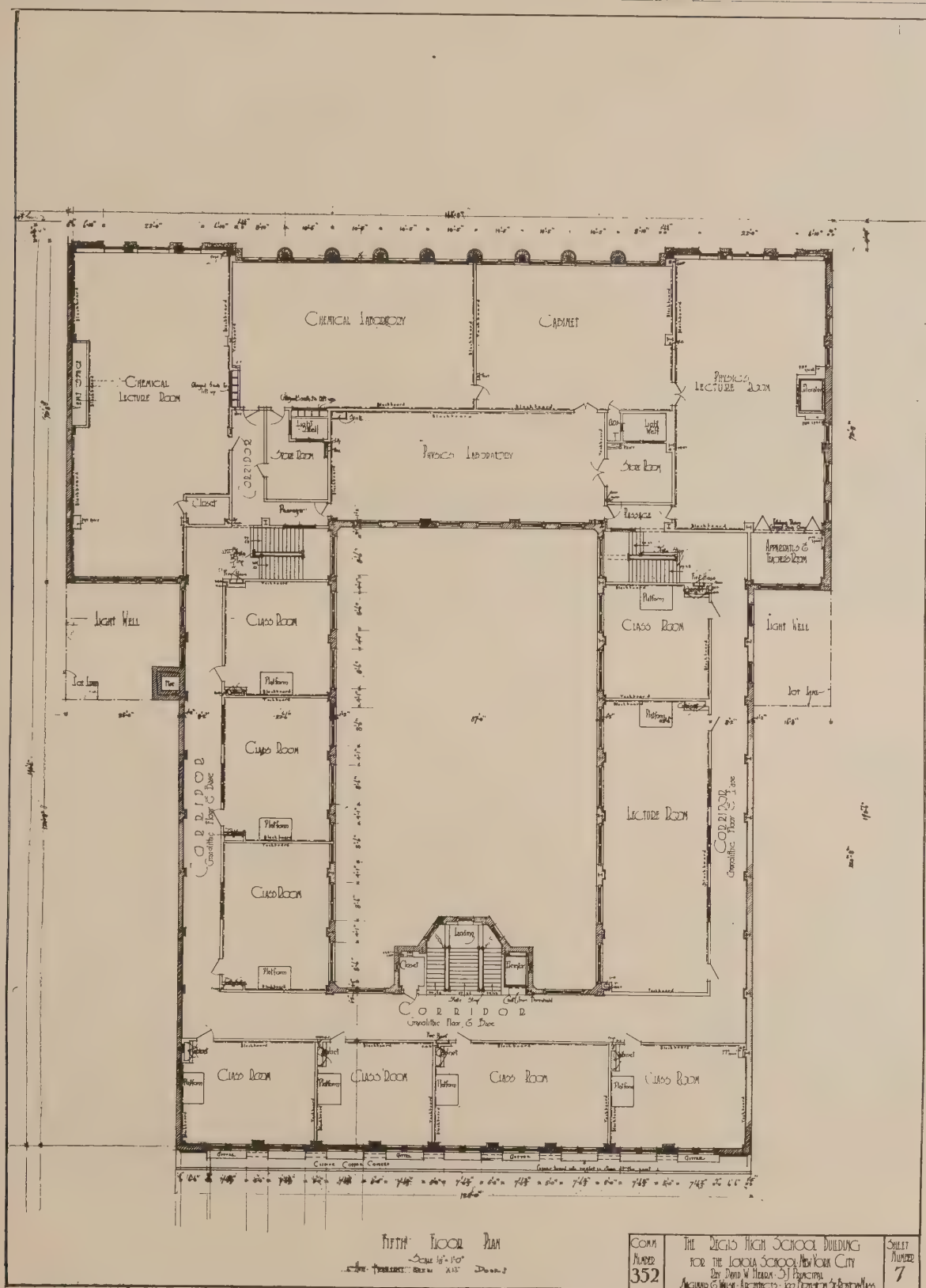

Chemical Laboratory
Cabinet
Chemical Lecture Room
Physics Lecture Room
Physics Laboratory
Store Room
Store Room
Corridor
Closet
Passage
Apparatus & Engines Room
Light Well
Class Room
Class Room
Light Well
Class Room
Class Room
Lecture Room
Class Room
Corridor Granolithic Floor 6 Deck
Corridor Granolithic Floor 5 Deck
Corridor
Granolithic Floor 6 Deck
Class Room
Class Room
Class Room
Class Room
Fifth Floor Plan
Scale 1/8" = 1'-0"
Comm. Number 352
The Regis High School Building
for the Loyola School, New York City
Rev. David W. Heelan, S.J. Principal
McGuire & Walsh, Architects - 100 Boylston St. Boston, Mass.
Sheet Number 7

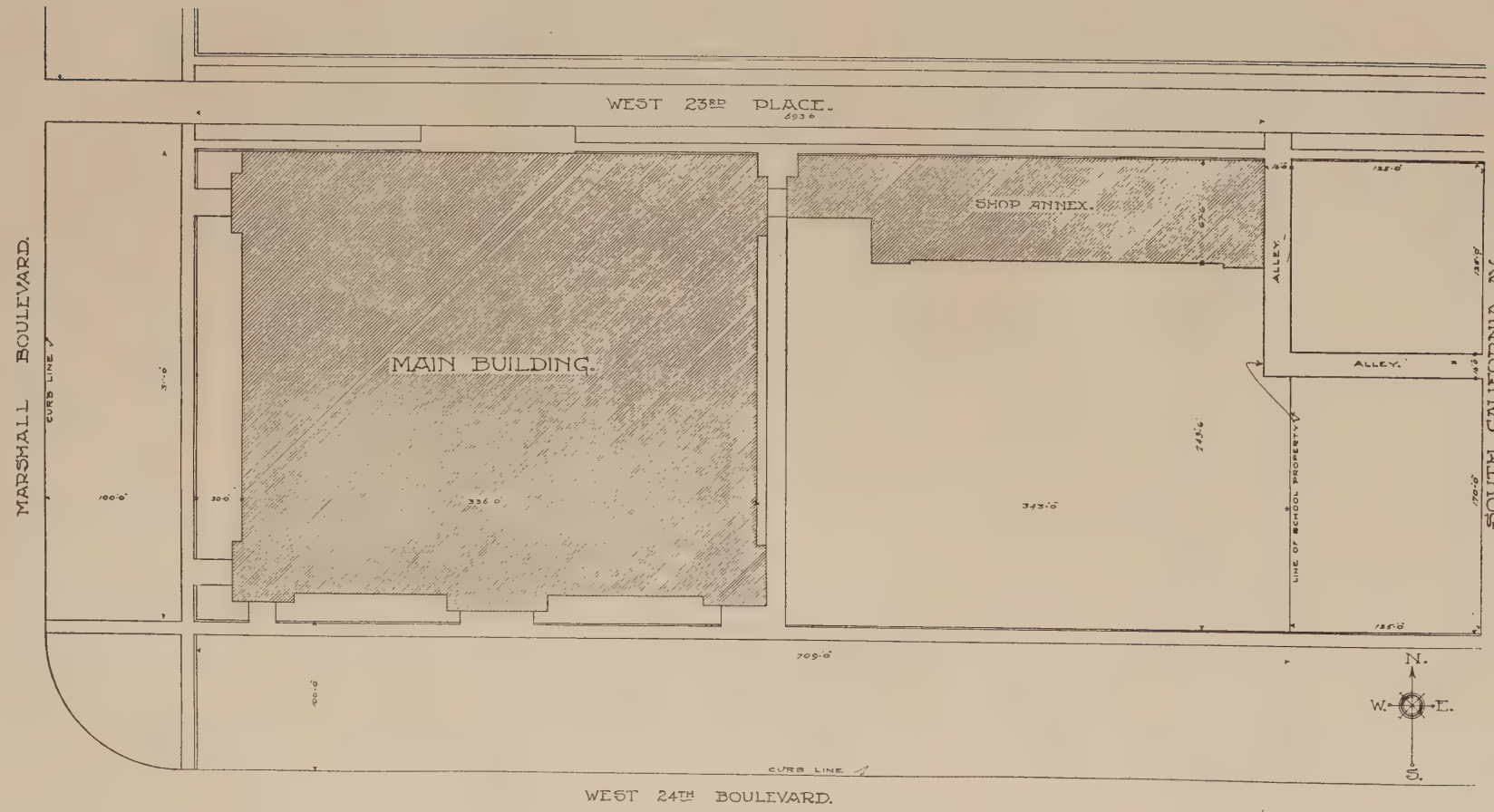
Fig. 654.

Mr. A. F. Hussander, Architect.

FIG. 655. — CARTER H. HARRISON TECHNICAL HIGH SCHOOL, CHICAGO, ILLINOIS.

Mr. A. F. Hussander, Architect.

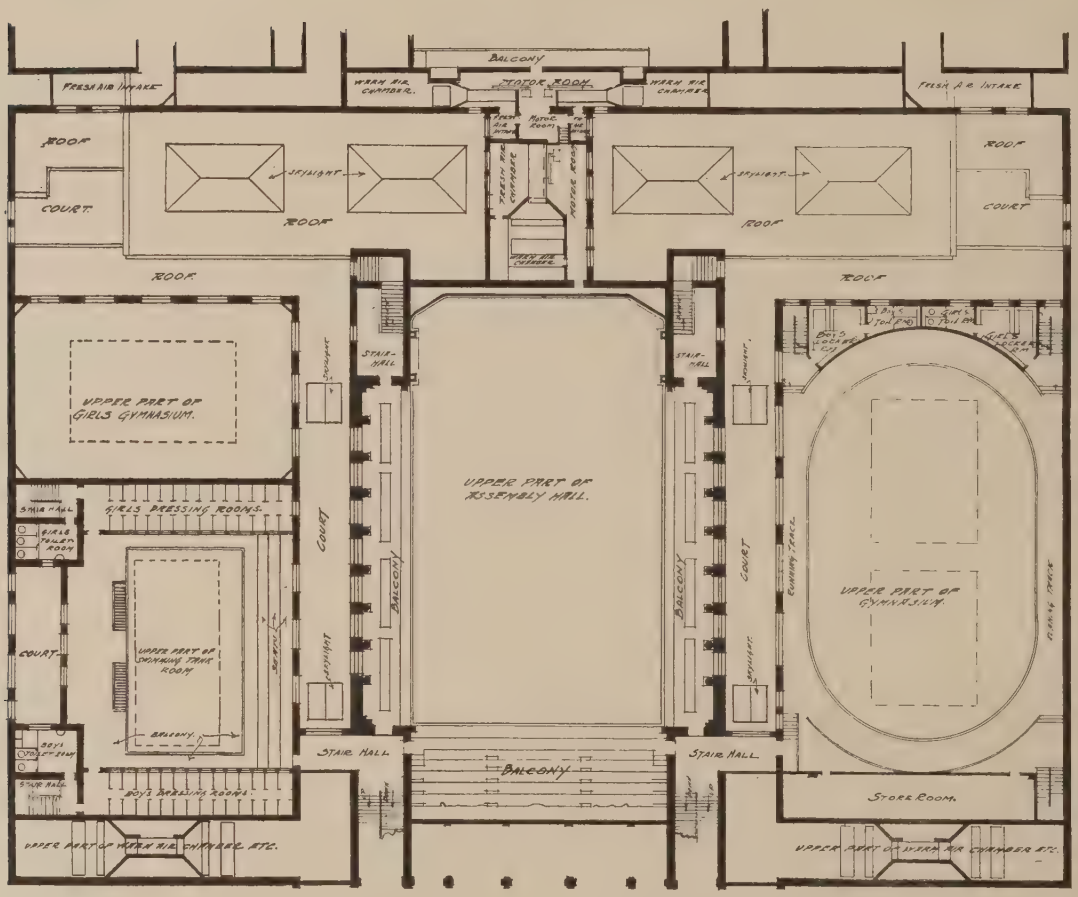
FIG. 656. — CARTER H. HARRISON TECHNICAL HIGH SCHOOL, CHICAGO, ILLINOIS.



PLAT PLAN.

CARTER H. HARRISON TECHNICAL HIGH SCHOOL — LOCATED AT MARSHALL AND W. 24TH BOULEVARDS.
A. F. MUSSANDER ACTING ARCHITECT.
BOARD OF EDUCATION CHICAGO ILL.
SCALE: 1/32 INCH = 1 FOOT.

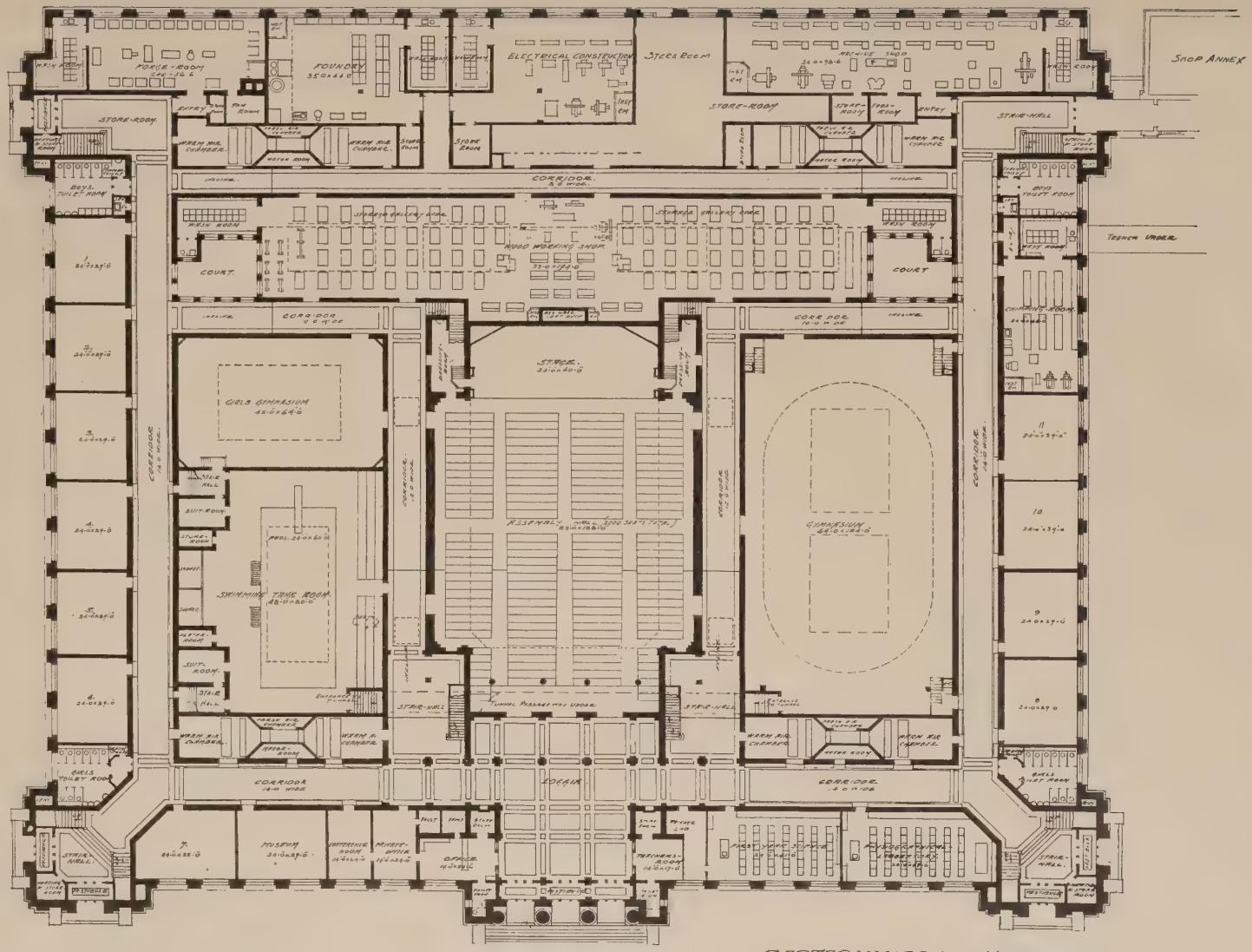
FIG. 657.



MEZZANINE FLOOR PLAN.
(BETWEEN 1ST AND 2ND FLOOR)

CARTER H HARRISON TECHNICAL HIGH SCHOOL — LOCATED AT MARSHALL AND W. 24TH BOULEVARDS.
A. F. MUSSANDER ACTING ARCHITECT
BOARD OF EDUCATION CHICAGO ILL.
SCALE: 1/16 INCH = 1-FOOT.

FIG. 658.



FIRST FLOOR PLAN.

CARTER H. HARRISON TECHNICAL HIGH SCHOOL — LOCATED AT MARSHALL AND W. 24TH BOULEVARDS
A. F. HUSSANDER ACTING ARCHITECT.
BOARD OF EDUCATION CHICAGO ILL.
SCALE: 1/8 INCH = 1 FOOT.

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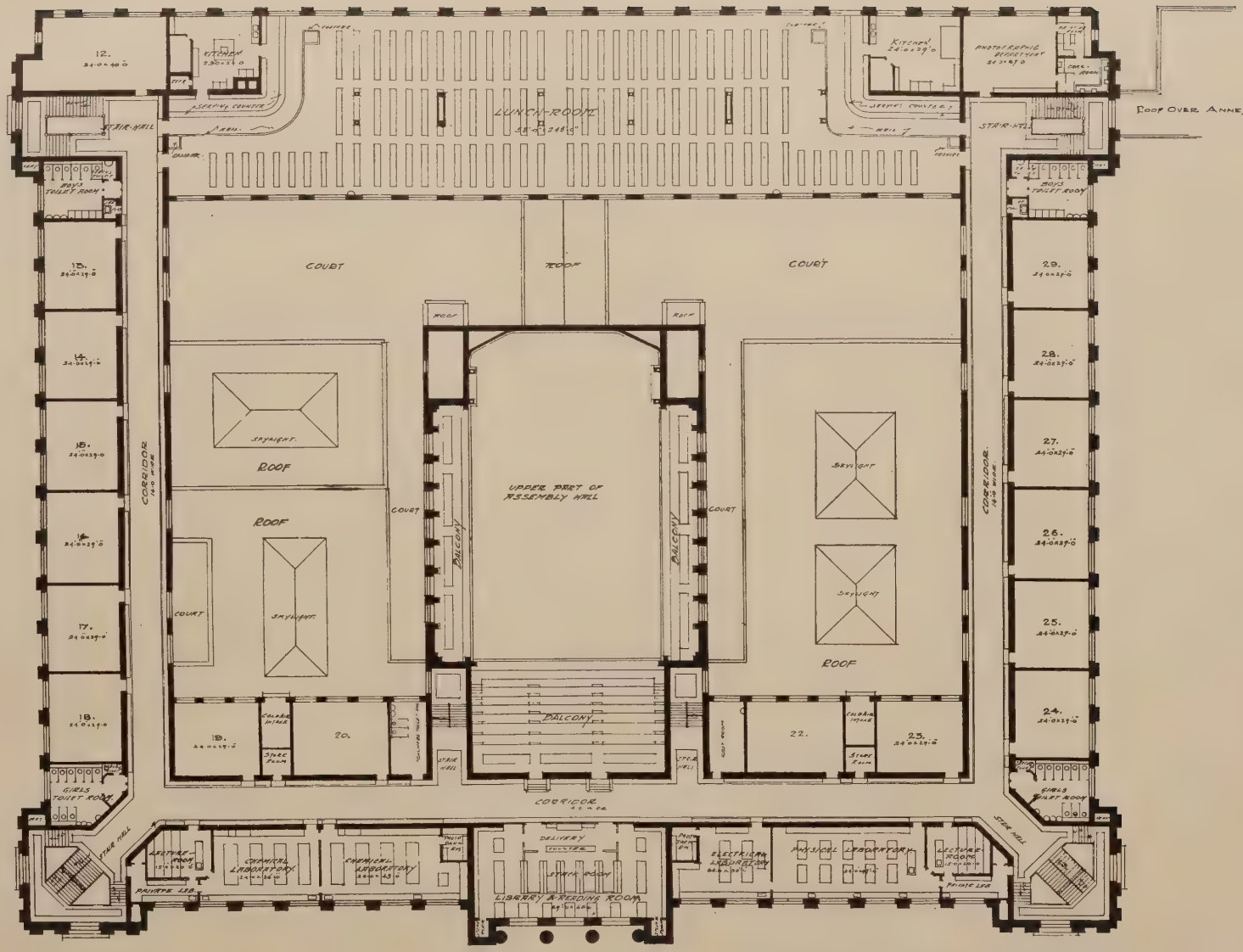
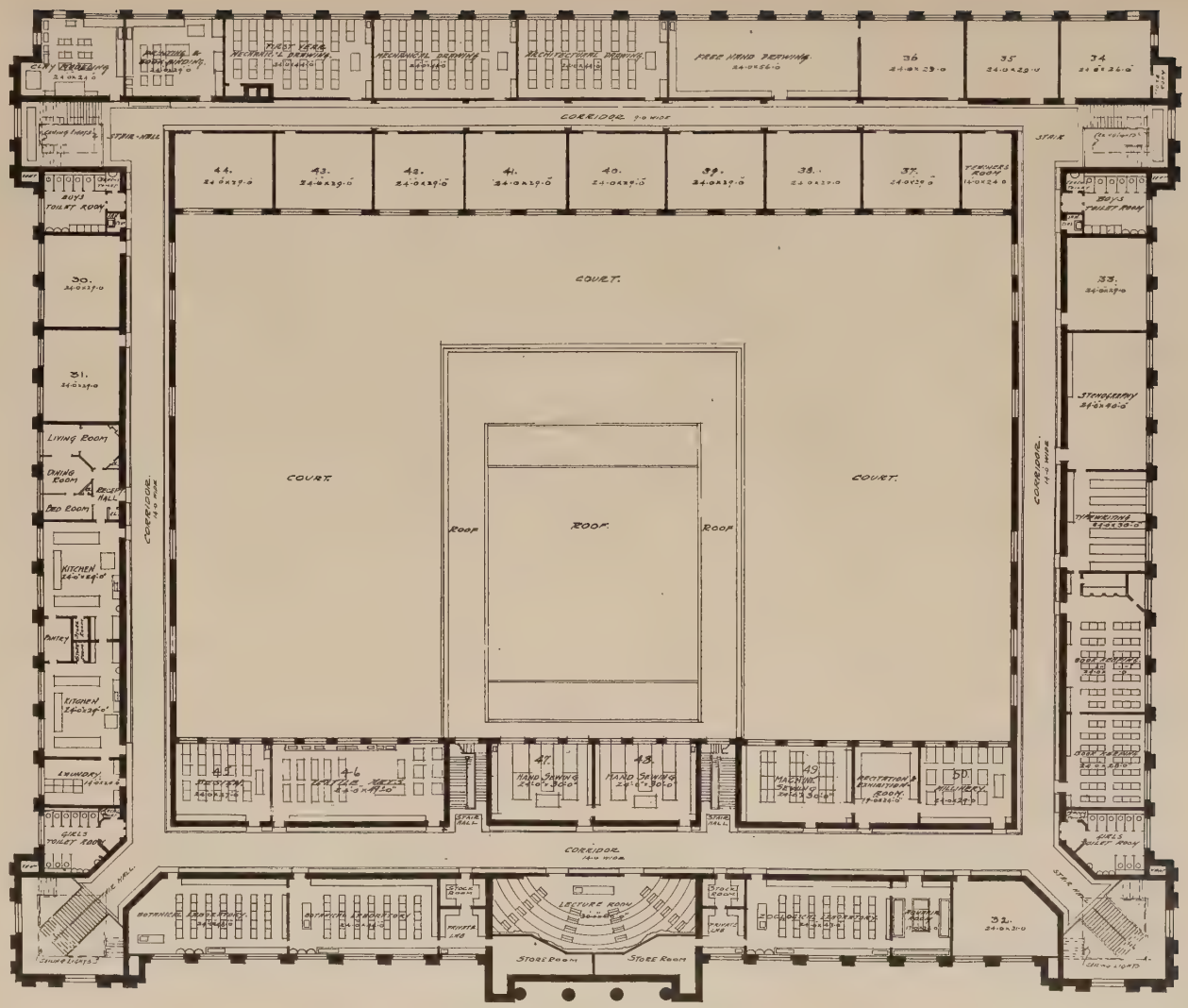
FIG. 659.



SECOND FLOOR PLAN.

CARTER H. HARRISON TECHNICAL HIGH SCHOOL — LOCATED AT MARSHALL AND W. 24TH BOULEVARDS. A. F. MUSSANDER ACTING ARCHITECT. BOARD OF EDUCATION CHICAGO ILL. SCALE: 1/16 INCH = 1-FOOT.

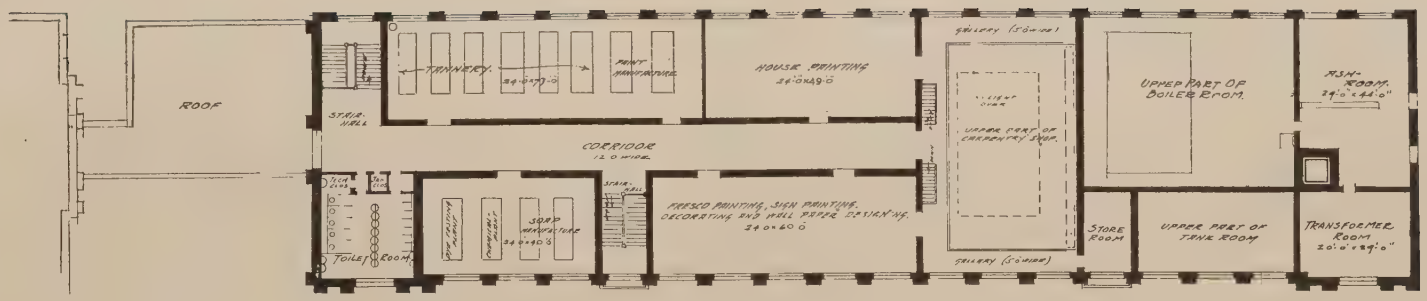
FIG. 660.



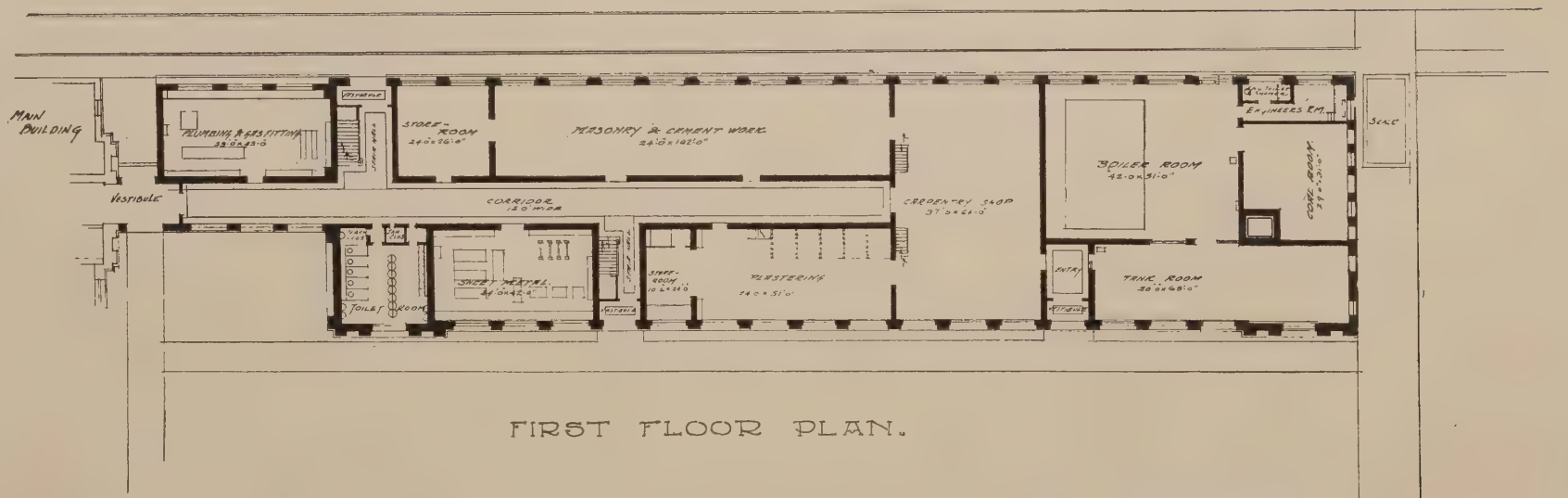
THIRD FLOOR PLAN.

CARTER H. HARRISON TECHNICAL HIGH SCHOOL — LOCATED AT MARSHALL AND W. 24TH BOULEVARD.
A. F. MUSSANDER ACTING ARCHITECT
BOARD OF EDUCATION CHICAGO ILL.
SCALE: 1/16 INCH = 1-FOOT.

FIG. 661.



SECOND FLOOR PLAN.



FIRST FLOOR PLAN.

CARTER H. HARRISON TECHNICAL SHOP ANNEX.
HIGH SCHOOL, LOCATED AT
MARSHALL AND W. 24TH BOULEVARDS.
A. F. MUSSANDER ACTING ARCHITECT.
BOARD OF EDUCATION CHICAGO ILL.
SCALE: 1/16 INCH = 1 FOOT.

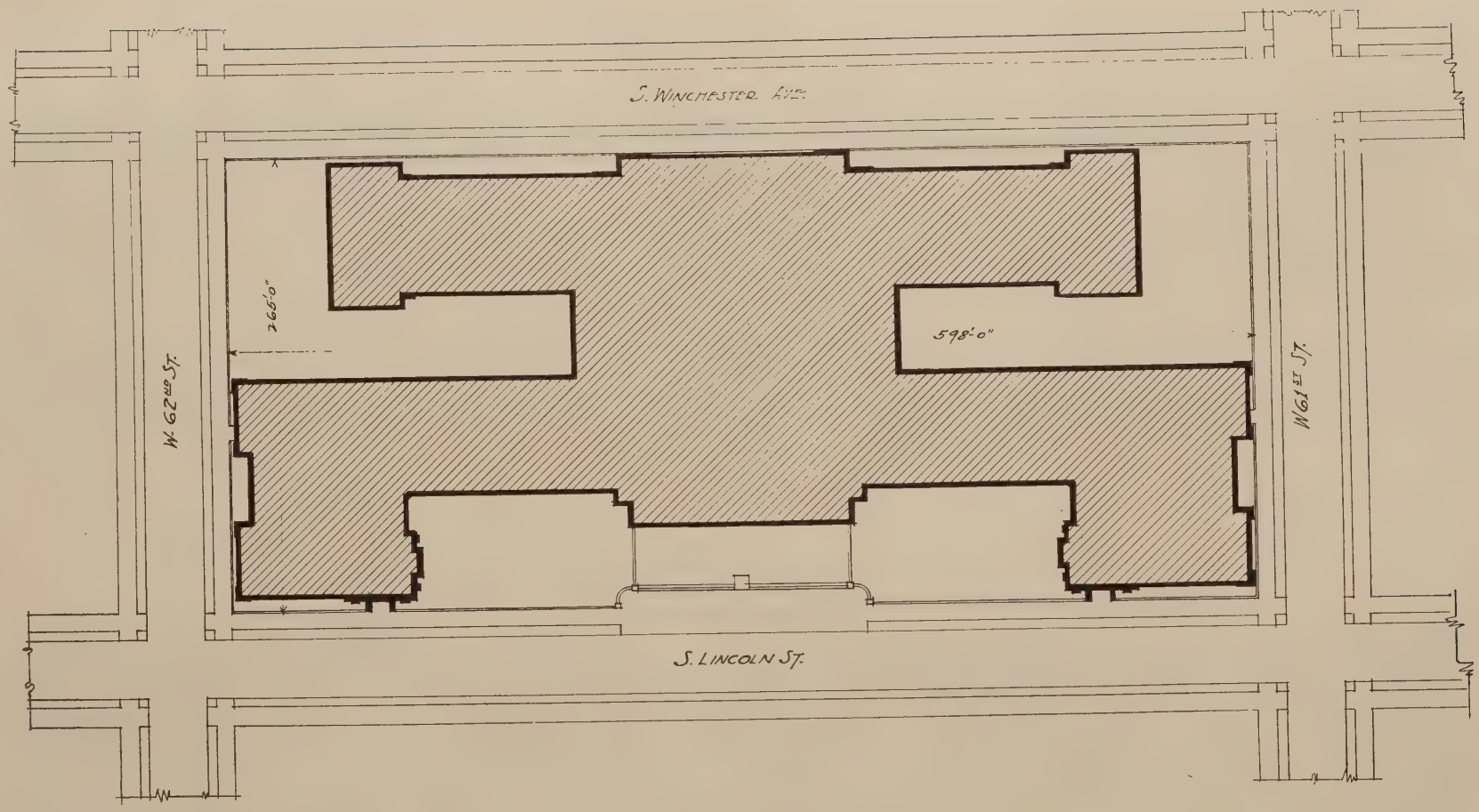
FIG. 662.

FIG. 663. — LINDBLOM HIGH SCHOOL, CHICAGO, ILLINOIS.

MT. A. F. Hussander, Architect.

FIG. 664. — LINDBLOM HIGH SCHOOL, CHICAGO, ILLINOIS.

MT. A. F. Hussander, Architect.



• PLAT PLAN •

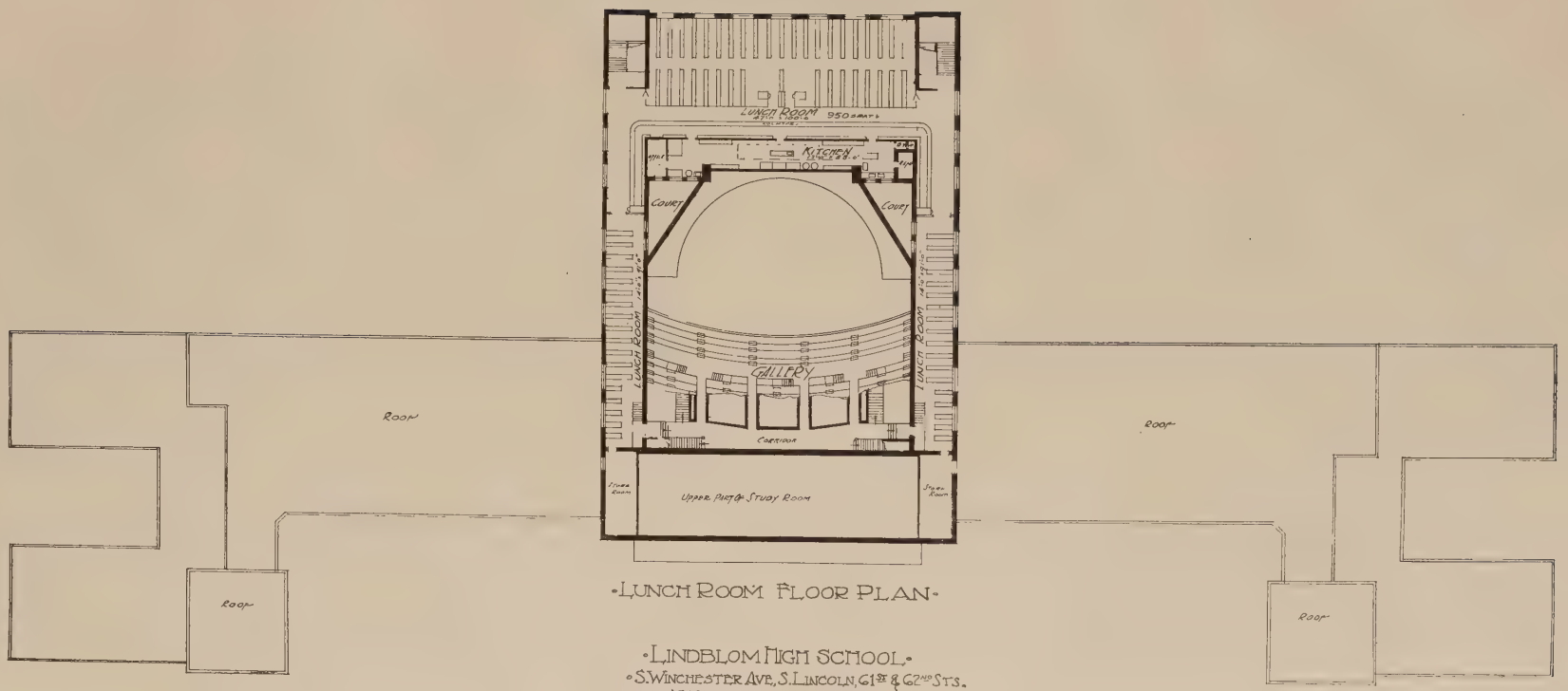
• LINDBLOM HIGH SCHOOL •

• S. WINCHESTER AVE, S. LINCOLN 61ST & 62ND STS. •

• A.F. HUSSANDER • ARCHITECT •

• BOARD OF EDUCATION • CHICAGO •

FIG. 665.

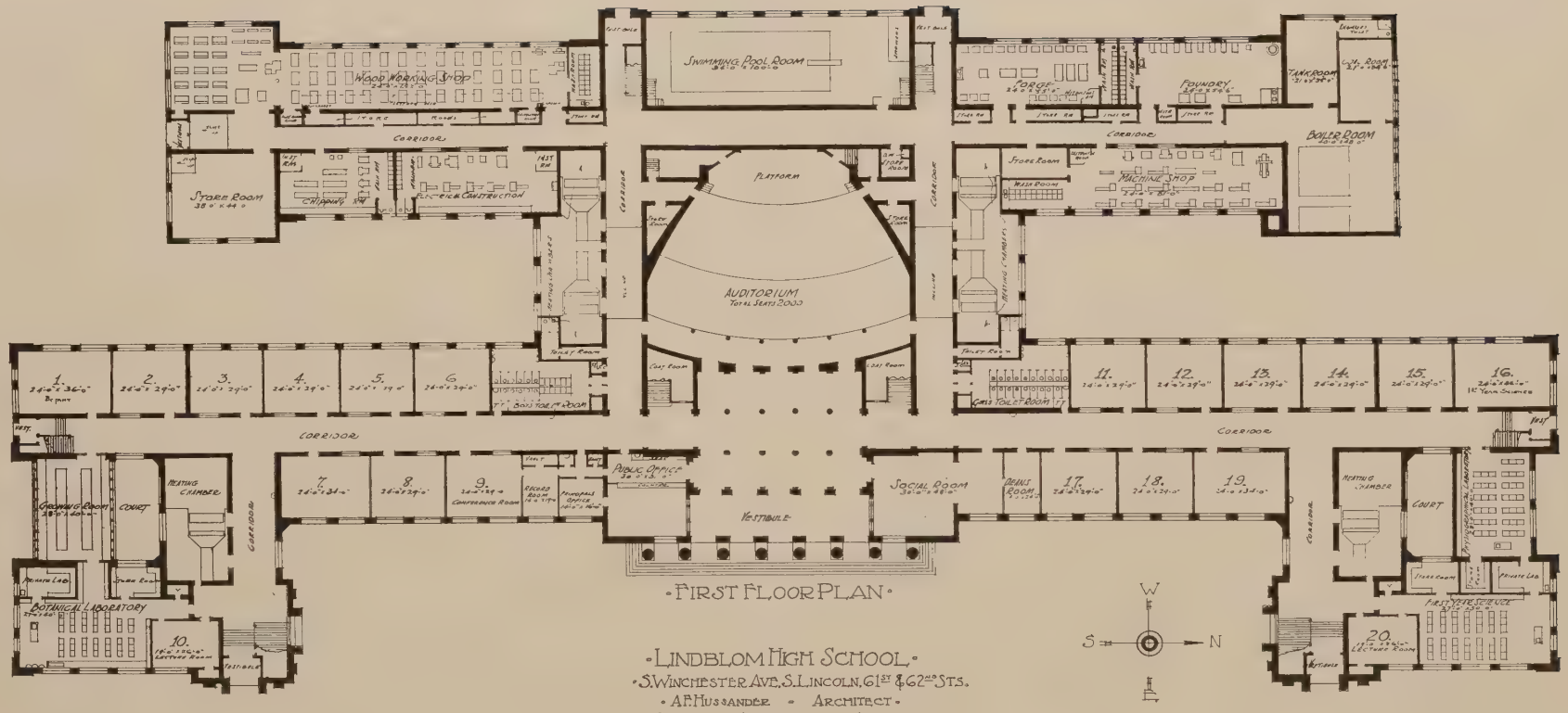


LUNCH ROOM FLOOR PLAN

LINDBLOM HIGH SCHOOL
S. WINCHESTER AVE., S. LINCOLN, 61ST & 62ND STS.
A. F. HUSSANDER, ARCHITECT
BOARD OF EDUCATION, CHICAGO

FIG. 666.

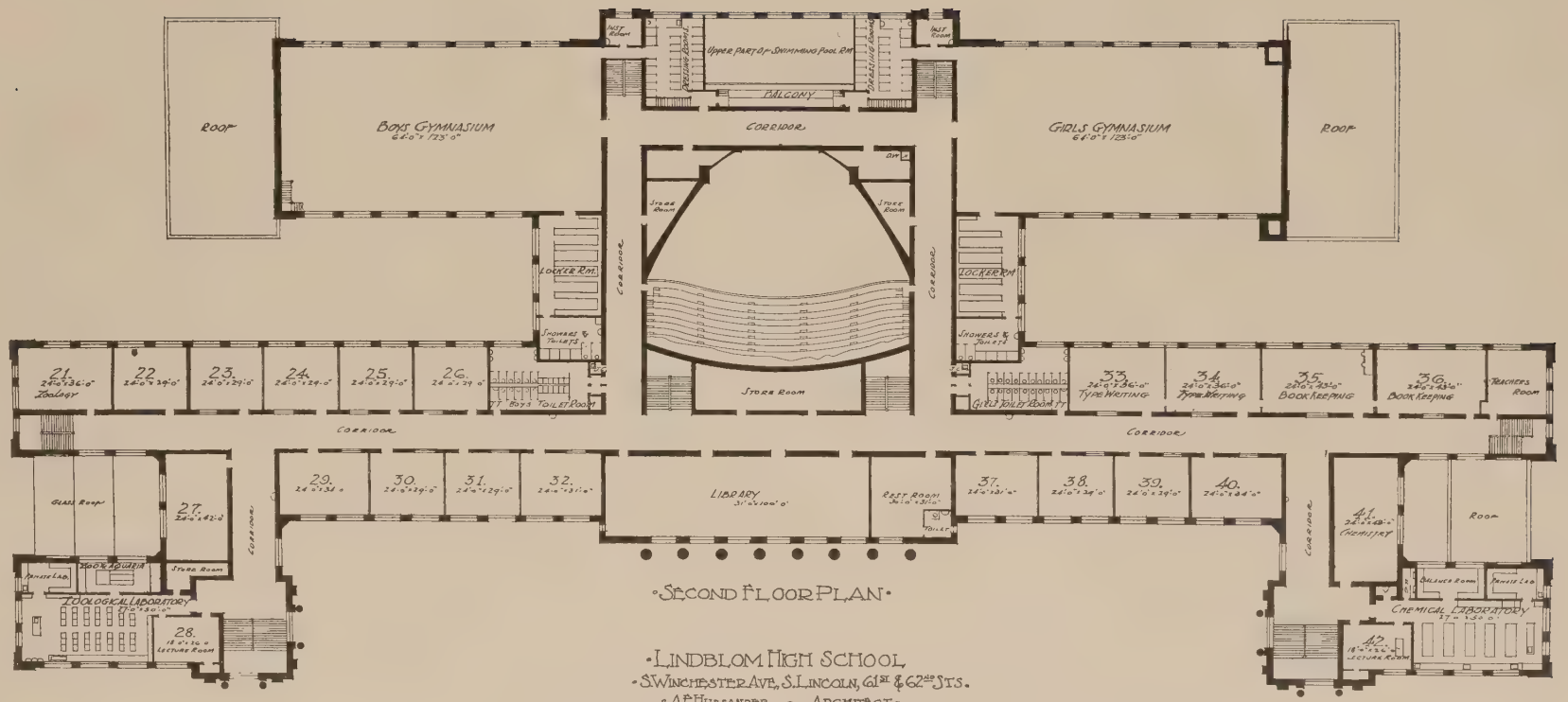
Mr. A. F. Hussander, Architect.



FIRST FLOOR PLAN

LINDBLOM HIGH SCHOOL
S. WINCHESTER AVE., S. LINCOLN, 61ST & 62ND STS.
A. F. HUSSANDER - ARCHITECT
BOARD OF EDUCATION - CHICAGO

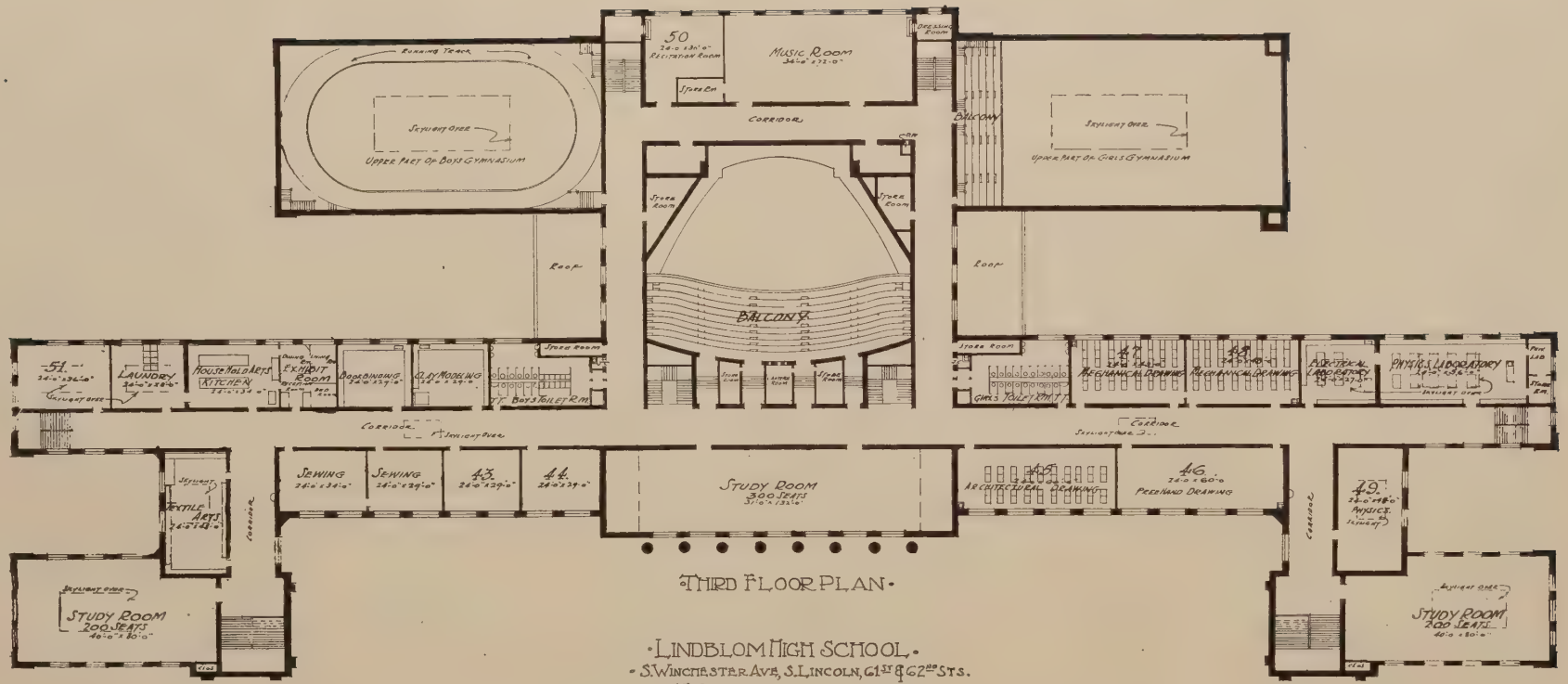
FIG. 667.



SECOND FLOOR PLAN

LINDBLOM HIGH SCHOOL,
S. WINCHESTER AVE., S. LINCOLN, 61ST & 62ND STS.
A. F. HUSSANDER - ARCHITECT
BOARD OF EDUCATION - CHICAGO

FIG. 668.



THIRD FLOOR PLAN

LINDBLOM HIGH SCHOOL.
S. WINCHESTER AVE, S. LINCOLN, 61ST & 62ND STS.
A. F. HUSSANDER - ARCHITECT.
BOARD OF EDUCATION - CHICAGO.

FIG. 669.

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* Especially good.

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